POWER PLANT ENGINEERING

VOL. XXXVI CHICAGO, FEBRUARY 15, 1932 No. 4

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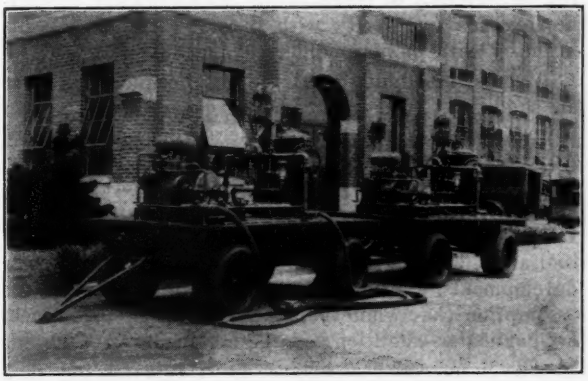
Published on 1st and 15th of each month, copyright 1932, by the Technical Publishing Co., 53 West Jackson Blvd., Chicago
New York Office, 171 Madison Avenue
Subscription price: U. S. A. $2 a year; Canada $3.95 a year including duty; other countries $3.50 a year. Single copy current issue: U. S. A. 15c, other countries 25c; except January 1st issue U. S. A. 50c, other countries 60c. Single copy back issue: U. S. A. 25c, other countries 35c; except January 1st issue U. S. A. 75c, other countries 85c.
Member, Associated Business Papers, Audit Bureau of Circulations.
Circulation of this issue 23,850.



Who Won the War?

WE GOT YOU that time. There is no argument—the Marines did!! The Navy didn't know there was a war on and the Army was still polishing the seat of the swivel chair but the Leathernecks sleep with one eye open (the other one is blind anyway) and were right on the job. And believe me, the enemy never has a chance with this new gas warfare.

Nothing new or powerful like Lewisite, just plain old chlorine but a good shot makes them curl up their toes. Horrible death but the Marines neither ask nor give quarter. A few of the enemy through the lines may mean a frightful epidemic in some city or community.

This is civilized warfare and part of a well directed campaign against bacteria in public water supplies. The above mobile units with Allis-Chalmers pumps and Wallace & Tiernan chlorinators were sold to the Marine Corps to assist them in carrying on the campaign. The balloon tires bring the modern spirit of aviation into the picture and it is reported that the navy supplies a gob to scrub the decks and make the Marines feel at home but this report is as yet unconfirmed by the Secretary of the Navy.

Coöperation is a wonderful thing and should be encouraged among all branches of the service. Air, land and water forces should combine to fight the common enemy.

And of course this coöperation should be extended to civilians. We all fight the common enemy High Costs, particularly High Power Costs. This battle calls for the finest kind of coöperation between isolated plant and central station forces. Often these two appear to be traditional enemies and many of the individual units on each side are unable to see how each can be the other's best ally. On page 170, Mr. Henschel gives a few pointers on this matter of coöperation to the theme song, Get Together.

WITH THE EDITORS

Yesterday, Today and Tomorrow

Never before has the industrial engineer had such full opportunity of coördinating his knowledge of engineering, his familiarity with plant conditions and his intimacy with power plant developments.

It must be admitted that no one formula will cover all conditions. One plant should generate all its own power, another can afford to generate only a part of it, while the next may not profitably generate any. Today, with the entire country covered by a net work of transmission lines, with all sizes and types of equipment developed to high efficiencies, with load control, demand limitators, bleeder turbines, electric heaters and similar developments, the engineer is free to proceed on the assumption that whatever equipment he needs to meet his particular conditions can be obtained.

The industrial heat balance is today extremely flexible. Process conditions may require the furnishing of steam at certain definite pressure and temperature conditions. The electrical demands may or may not coincide with the steam demands.

In some cases it may be possible to increase the boiler pressure above that required by the process and use a bleeder or back pressure turbine to expand the steam partially on its way to the process equipment. This is variously known as using the prime mover as a reducing valve, as by-product power and by other names which are objected to by many on purely technical grounds that have no real bearing on the subject. The important thing is that steam used in processes can first be used to generate power and, conversely, steam used to generate power can be used later in process work. The advisability of doing this depends upon local conditions.

Again, continuity of service is a factor which many industries must consider and which is responsible for many independent plants, some generating all their own power and some carrying only an essential load. The continuity of purchased power service is often a deciding factor, especially outside the metropolitan districts.

Some industries have power available which they cannot use during certain periods. This may be from waste heat, surplus gas, or irregularities in steam and power loads. In many sections of the country industrial plants are coöperating with central station service to take care of this excess power. As a whole, public service companies have neither supported nor approved of this coöperative agreement or interchange, although individually there has been some support and the practice of utilities building and operating power plants for certain industries is both an admission that the practice is feasible and a step to prevent the individual industries carrying out the program individually and forcing coöperation by the utilities.

From among the dozens of possibilities the engineer should lay out a program of development and, if unable to carry it through, he should be able to present sufficient evidence to have his plant checked by a survey by some competent consulting engineer. Now is the time to get detailed studies and plans underway so that there will be no delay when the capacity is needed.

Yesterday we were hampered by rigid heat balances, limited equipment and unavailable public service supplies. Today conditions have changed, equipment is developed to nearly its ultimate efficiency and flexible enough to meet all conditions. Tomorrow we will need the power capacity to meet business demands but to take advantage of lower costs these plans for modern efficient generating equipment must be made today.

Getting started is not so difficult. Get out the old records, charts and logs and make up a heat balance. Even a rough approximation is better than nothing for it at least indicates where more data is needed. Then let some of the manufacturers help in planning improvements. If they can't make good, you are at least ahead by knowing what your conditions actually are. You win either way.

Compensation for Transferring Employes

Successful executives are those who have acquired the knack of keeping their subordinates acceptably contented in their work, at the same time securing from them sufficient service to make their employment profitable to the employer. Monetary compensation is, of course, the principal factor and practically the only one that comes into the practice of competitive bidding for and holding competent employes.

Other factors, however, enter into the desirability of a position, in the minds of many men, particularly those who are in the development stage, anxious to advance in their chosen profession and willing to pay the price of hard work, long hours of study and extra time investigating and experimenting. Such men consider the first few years as a stepping stone to more responsible positions with greater compensation.

Too frequently employes are content to continue on, year after year, doing the same routine work with little or no progress in either quantity or quality, even resenting instructions which would change slightly the accustomed order of work. The ability and willingness to make changes, while not confined to young men, is more prevalent among them than among those past middle age whose work has not been greatly diversified.

Fortunate, therefore, is the chief engineer who is capable of developing an organization that is willing to coöperate in making progressive changes in the work of the plant. Many have found that the best way to prevent an organization from becoming stale is to transfer the men from one class of work to another, advancing them as rapidly as opportunity and their ability warrant.

Such a policy will frequently take a man into an entirely different department or even an outside position and necessitate the inconvenience of securing and training a new man but, as compensation, the chief will develop a loyal organization of progressive men through whom he can, without antagonism, perfect a program.

Suggestions for Profitable Reading

Simplicity in Architectural and Mechanical Design Characterizes New Harding St. Station

Harding Street Station described in detail in this issue, is one of the few power plant structures that have received the architectural treatment and attention warranted by the influence of this phase of central design on the public relations of power utilities. No attempt has been made to disguise the plant; it is obviously a power plant, yet the simple treatment of lines and the modest decoration make it distinctive. The turbine room of tan and green sets a standard of color harmony and simplicity.

Nor does the mechanical design lag behind the architectural treatment. Following the modern trend toward simplicity, as contrasted with the feverish activity of a few years ago when every piece of equipment had to be designed special, the station designers have used standard equipment and modern layouts in a manner that can be studied with profit by many companies. Control facilities, flexibility of operation and circulating water system using variable-pitch, propeller-type pumps are particularly interesting features.

Balance and Flow Diagrams Made Clearer by Using Standard Symbols

For many years electrical diagrams have been drawn with standard symbols. During the same period, symbols used in mechanical diagrams, such as heat balances and flow diagrams, have followed the dictates and artistic ideas of the individual draftsman. Recently, however, the International Electrotechnical Committee, with suitable American representation, has taken up this matter and has recommended standard symbols, which are discussed in this issue. It is not to be expected that all these symbols will be adopted in this country at once but many can be used to advantage and it is to be hoped that in time these conventional symbols will be universally used in all countries. The saving in drafting time will be well worth while.

Use of Pulverized Fuel, Durability of Wire Rope, Effectiveness of Electrical Oil

Pulverized fuel supplied from a central pulverizing and distributing plant will simplify operation in many cases where high-temperature process heat is needed. The method described in this issue by Mr. O'Neil puts coal on a par with oil so far as convenience is concerned and seems capable of wide adaptation.

Sometimes the undeterminable stresses in a machine are important factors in its safety and durability. Reduction of such stresses to a minimum is therefore desirable and methods outlined by E. J. Kunze of special manufacture or treatment of wire rope should have careful attention by the user. The same principle applies to other equipment, that design and manufacturing methods should be such as to reduce undeterminable stresses to a minimum.

You can scarcely think of a power engineer anywhere, in industry or central station, hotel or hospital, small plant or large one, who does not have charge of switches or transformers or some other type of electrical equipment using insulating oil. Oil for use in these switches or transformers must be free of impurities. Presence of even a small fraction of a per cent of moisture or sludge, which would have little or no effect on the lubricating quality of oil, may seriously impair its insulation value.

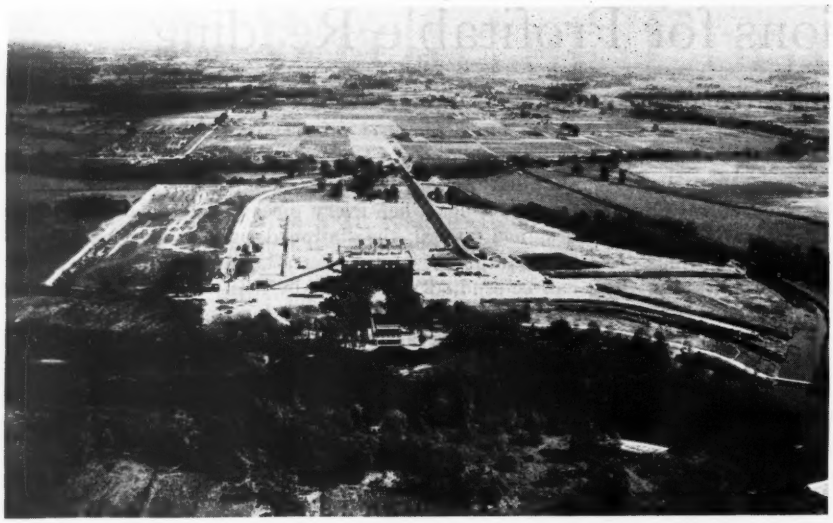
Improvement in the method for ensuring uncontaminated oil, as described in this issue, is of vital interest and the use of such methods will give peace of mind to the power executive by guarding against trouble. Test and treatment of oil as a part of maintenance routine is important, because ordinary inspection is inadequate to detect the small amount of contamination that renders electrical oil ineffective. With complete purification, test routine can be simplified.

Small Boiler Plants Can Have the Advantages of Water Walls at Low Cost

Not always are industrial plants able to take full advantage of modern boiler developments because of limited space and the added cost of water walls. This problem has been solved to some extent in the past by low head room type boilers and careful furnace design, which allow high ratings. Water walls have remained expensive, however, largely because of the necessary header construction and added circulators. One interesting solution of this problem is offered by the S & G steam generator, an extremely unconventional two-drum, bent-tube design in which the two outside rows of tubes have been extended to form a water-cooled furnace. Headers and circulators have been eliminated, the flame travel has been lengthened and the furnace volume increased at practically no extra cost and best of all it is well adapted to limited areas such as demanded by old h.r.t. replacements. Industrial plants may thus improve economy more readily.

Closer Cooperation Between Industrial Plants and Public Utilities

Relative merits of private plant power and central station power have been much discussed and the proponents of the respective classes have argued hot and furiously. As in most heated controversies, the answer to the problem involved probably lies midway between the two extremes and so it appears to be in this case. Arrangements are frequent in which a certain amount of power is generated and the rest purchased, under a coöperative agreement between the private plant and the public service company. This is a phase of power plant work in which engineers of both private plants and central stations should be vitally interested, since it is probably bound to affect them sooner or later. The series of articles by O. H. Henschel beginning in this issue is devoted to analyses of this problem for a number of specific plants.



Aeroplane View of New Indianapolis Power and Light Co. Station Now in Service. Initial Section with Two 35,000-kw., 0.80 Power Factor Turbo Generators and Eight 11,810-Sq. Ft., 440-Lb., 725-Deg. F. Stoker Fired Boilers with Water Walls, Economizers and Air Heaters Now in Service

Harding Street Station at Indianapolis

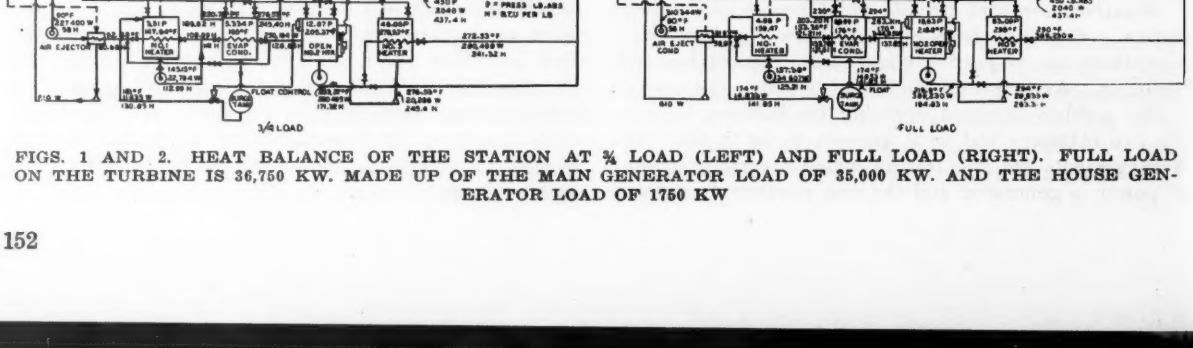
Unusually fine architectural treatment, high efficiency and reliability with standard equipment and circulating water system with adjustable blade propeller pumps are but a few of the interesting features.

WITH A GENERATING capacity of 70,000 kw., the new Harding Street Station will approximately double the system capacity of the Indianapolis Power & Light Co. at Indianapolis, Ind. This new station designed and constructed by the Management and Engineering Corp. is located on the White River about 5 mi. southwest of the city and will supply the present 12 district substations with power through a new 50-mi., 132-kv. loop and four high tension substations operated by supervisory control from Morris St. substation. Interconnection is made with the Indiana Electric Corp. lines at its Lenore substation just outside of Indianapolis.

Initial installation of two 35,000-kw. Westinghouse units and eight 450 lb., 11,810 sq. ft. stoker fired Springfield boilers completes the first half of the station planned for an ultimate capacity of 140,000 kw. In the station are a number of distinctive features; the unusually good architectural treatment of both interior and exterior; the screen house and circulating water system; the unit boiler construction; coal storage facilities; centralization of control and last but not least, the utilization of standard equipment in such a manner as to give maximum flexibility and operating reliability with a low initial cost and high efficiency.

General arrangement of the plant can be seen from the aerial photograph in the headpiece. The outside pulverized coal storage on the left has a capacity of 62,000 t. Coal received by rail can be dumped directly to the track hopper for immediate transfer to the bunkers or can be dumped in one of three pockets at the storage area to be stored by Gantry crane. Coal is reclaimed by the same crane and a belt conveyor across to the track hopper as shown in Fig. 5.

This drawing also shows the arrangement, size and speeds of the 250-t. per hr. Link-Belt conveyor system from the track hopper, through the crusher house to the 2600-t. coal bunker in the boiler room. Following the American crusher is a Charleroi sampler which removes a 10—15-lb. sample every minute, crushes and splits it



FIGS. 1 AND 2. HEAT BALANCE OF THE STATION AT ¾ LOAD (LEFT) AND FULL LOAD (RIGHT). FULL LOAD ON THE TURBINE IS 36,750 KW. MADE UP OF THE MAIN GENERATOR LOAD OF 35,000 KW. AND THE HOUSE GENERATOR LOAD OF 1750 KW

twice and delivers a finished sample equal to about a pint sample from every four carloads. Indiana coal averaging 10,950 B.t.u. per lb. is burned, a typical analysis in per cent running: moisture 11.34; volatile 36.90; fixed carbon 39.50; ash 12.26 and by separate determination, sulphur 3.75.

Boiler Room

As can be seen from the photograph, Fig. 6 and the cross section Fig. 3, the firing aisle of the boiler room is in keeping with the architectural treatment of the plant as a whole. The clean cut, compact, yet roomy and light arrangement is at variance with the usual stoker fired plant and compares favorably in appearance with the best pulverized coal plants.

This is made possible by the vertical unit arrangement of the boilers which, with the exception of the three-pass boiler, offers a straight upward path for the gases from the stoker through the boiler, economizer, air heater and induced draft fan to the stack. The setting and arrangement are shown by Fig. 3. From the basement floor to the boiler room roof is 107 ft., leaving plenty of room for the conveyor belt and coal bunker without crowding. From the bunkers, coal is fed to each stoker hopper through two coal spouts, Fig. 9, each equipped with a Richardson automatic scale.

Boilers of Springfield make cross drum type have 11,810 sq. ft. of boiler surface, with 838.5 sq. ft. of Drake water and 388.5-sq.ft. air-cooled walls, a 2540-sq. ft. Elesco superheater, a 5760-sq. ft. Foster Wheeler economizer and a 17,800-sq. ft. Ljungström air preheater. Each boiler is fired by a 10-retort Westinghouse underfeed stoker with clinker grinder and submerged ashpit flooded to a level of approximately 1 ft. above the center line of the grinding rolls. The projected grate area is 348.61 sq. ft. and the furnace volume 6700 cu. ft. Ashes are removed by a Hydro Ash sluice system.

Each boiler has a normal capacity of 124,000 lb. of steam per hr. or a maximum capacity of 190,000 lb. per hr. of 440 lb. g., 717 deg. F. steam. As shown by the plan, Fig. 4, eight of these units are installed, four boilers on each side of the firing aisle. Steam outlets from the superheaters of two boilers on each side are connected together by a Y fitting from which a 12-in. steam line leads to a manifold in the basement. The two boilers on the opposite sides of the aisle have a similar connection through another 12-in. line to the same manifold. These four boilers and one turbine normally operate as a unit although the manifolds are cross connected so that either group of boilers can be used with either turbine.

Normally three boilers will carry one turbine, having the fourth down for repairs but in an emergency two boilers operating at maximum output are sufficient to carry full load on one turbine. Each boiler has one induced and one forced draft fan, each with two driving motors of different speeds to give flexible operation. The higher speed will be used above the normal steam output of 124,000 lb. per hr. Induced draft fans discharge directly to individual steel stacks so that long smoke flues are eliminated.

Under normal steaming conditions, the unit is designed for the following temperatures: gas leaving the boiler, 735 deg F.; leaving economizer 490 deg. F.;

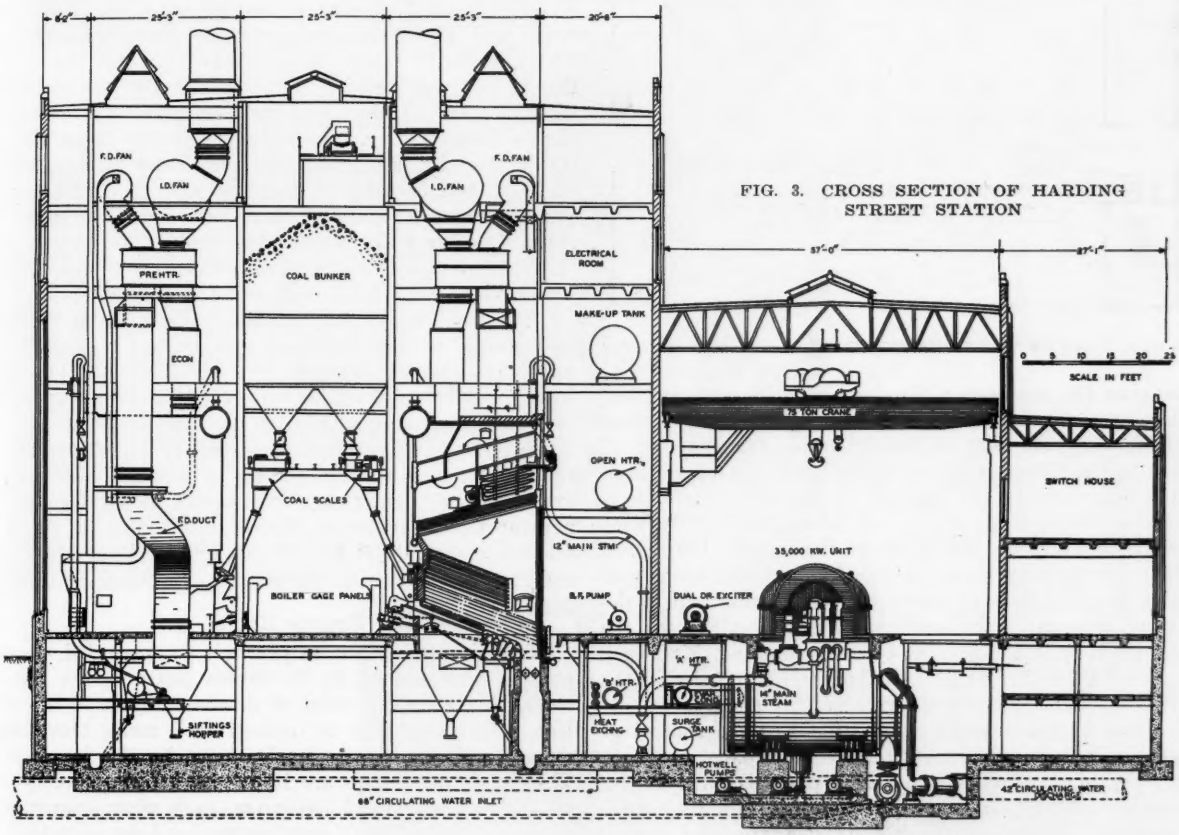


FIG. 3. CROSS SECTION OF HARDING STREET STATION

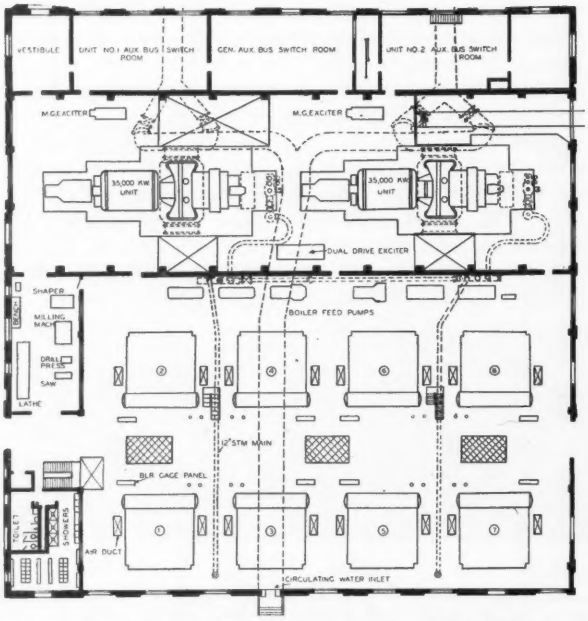


FIG. 4. PLAN OF THE PRESENT STATION WITH TWO UNITS

leaving the air heater 278 deg. F. Air entering the heater at 80 deg. F. is heated to 311 deg. F. Forced draft fans take most of the air supply from the top of the boiler room, giving a ventilating action up through the boiler room. The balance of the air to the fans is drawn through the air cooled section of the furnace walls in which the air is heated from about 100 to 200 deg. F. Directly above the fan in the boiler room roof is a monitor through which air can be admitted as desired to control the suction pressure. Air from the heater is split and carried by ducts running down each side of the boiler to the windbox and to nozzles in the front and rear walls to provide overfire air.

One of the features of the plant is the control of each unit centered in a complete control panel as shown by the photograph Fig. 6. Each panel is built with a canopy under which are placed opera lights giving a uniform illumination over the flush mounted instruments. Each panel has a 10-pointer draft gage, CO_2 recorder, 8-pen thermometers for gas and water temperatures, water level recorder, steam and feedwater flow meters, steam gage, steam pressure and temperature recorders and combustion control equipment.

Turbine Room

In the present section of the turbine room are two Westinghouse turbine units operating at 400-lb., 700-deg. F. throttle pressure and set over a 33,000-sq. ft. Westinghouse 2-pass condenser. They are rated at 35,000 kw. and generate 60-cycle, 3 phase power at 13,800 v. Each generator is connected directly to the low side of a bank of three 14,583-kv-a., 13,800/132,-000-v. transformers located in the adjacent outdoor switchyard. All switching is done on the high tension side which is laid out on the double bus double breaker scheme.

Each turbine has four extraction points, the first of which is blocked off and the last three of which, at the 8, 15 and 19 stages, are used for feedwater heating. No atmospheric relief connection is provided, the condenser being protected by a vacuum trip on the turbine oil governor and sheet lead blow out plates in the turbine exhaust casing. Each condenser has three 200,-000-lb. per hr. motor driven condensate pumps, two of which will be used for full load operation. Vacuum pumps consist of two stage steam jets with a total capacity of 40 c.f.m. at 70 deg. F. and 29 in.

As in the boiler room, complete control of each turbine and its auxiliaries is centered in a gage board or control panel which can be seen in Fig. 7, and in the photograph with the list of equipment. Instruments are black enameled, flush mounted. In addition to steam pressures and temperatures, indicating and record instruments at all points from the turbine to the condenser, the board contains flow meters for steam and condensate, conductivity recorders on condensate and evaporator condenser, pyrometers for generator temperatures, load indicator, moisture indicator in generator air cooling ducts, CO_2 fire extinguisher control and eight auxiliary control switches.

Screen House

Two circulating pumps per unit are provided, these pumps being located in the screen house at the river bank. A plan and section of this building is shown in Fig. 8. Arrangement of intake, trash racks, traveling screens and pumps are clearly shown by the drawings. The circulating pumps are 18-in. vertical propeller type with a capacity of 17,500 g.p.m. each when operating against a head of 24 ft. or when the head drops to 16-ft. head with one pump operating, the capacity increases to 22,000 g.p.m. Two of the pumps, one for each unit, have variable pitch propellers designed to take advantage of variable capacity requirements. A sewage disposal plant is some distance up the river and the circulating water is chlorinated in order to prevent the growth of algae in the condenser and piping. Water is carried from the screen house, under the boiler room

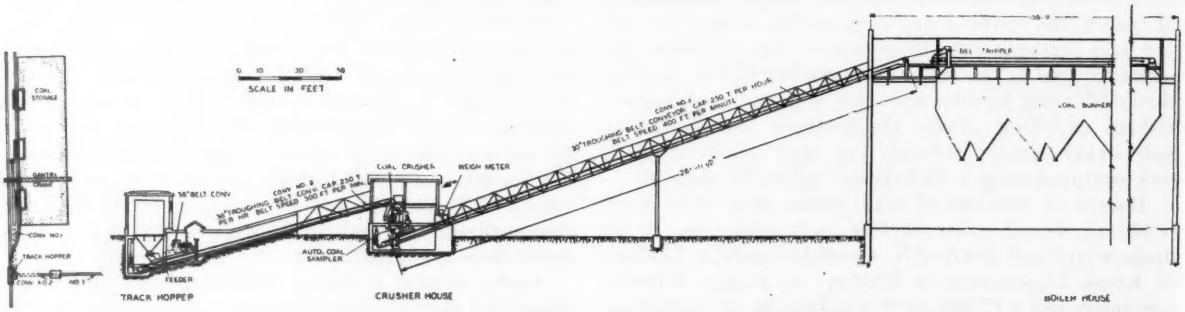


FIG. 5. THE COAL CONVEYING SYSTEM HAS A CAPACITY OF 250 T. PER HR.

to the condensers by 72-in. precast concrete tunnels and discharged on the opposite side of the turbine room through 42 to 72-in. tunnels and open channel to Lick Creek, a branch of the river which discharges about 300 yd. below the screen house. Velocity in the 72-in. tunnel is 5.47 ft. per sec. at full capacity.

This circulating water arrangement is an excellent example of utilization of the natural lay of the property. During low water, the river flow is not sufficient to carry the entire plant capacity and recirculation had to be provided. This is done by means of two dams, one fixed and one with a variable crest as described below, the recirculating water traveling about 3300 ft. or 5/8 mi. through open channels before again reaching the screenhouse.

At the plant site, the river splits to form an island about 1000 ft. long as shown by the headpiece. The screen house is located on the smaller branch just below the tip of the island. Below the screen house is a fixed dam elevation, 663 ft., which maintains the desired pool level. Below the island and the junction of Lick Creek is a Boule and Tainter gate dam. The crest of the dam can be controlled and during periods of low water, the natural current of the main stream is reversed, the return water cutting across the branch flow into the main channel and up to intake. In the course of construction, some 3/4 mi. of new channel was made for Lick Creek to straighten it in order to bring it within the property lines and prevent its crossing the main road twice.

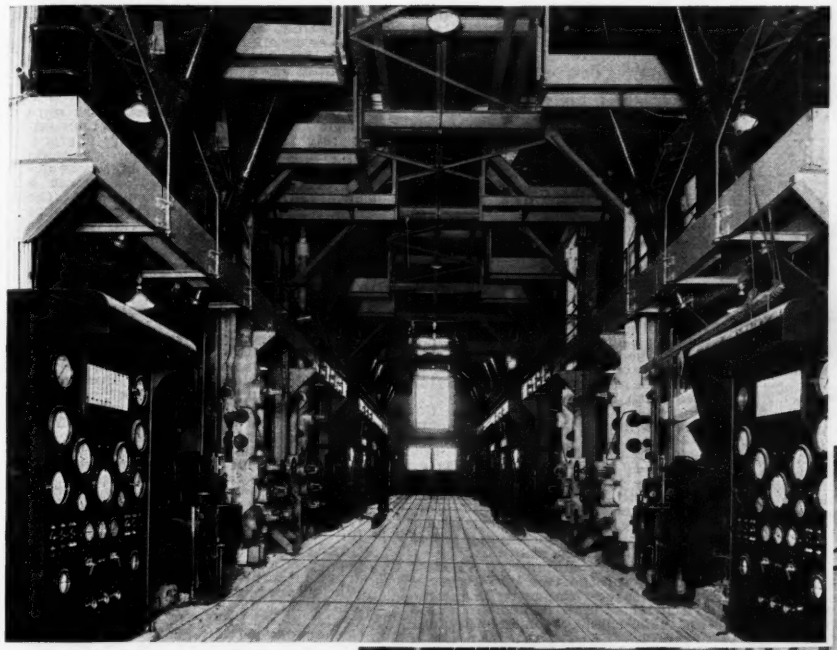


FIG. 6. FIRING AISLE AND BOILER CONTROL PANELS

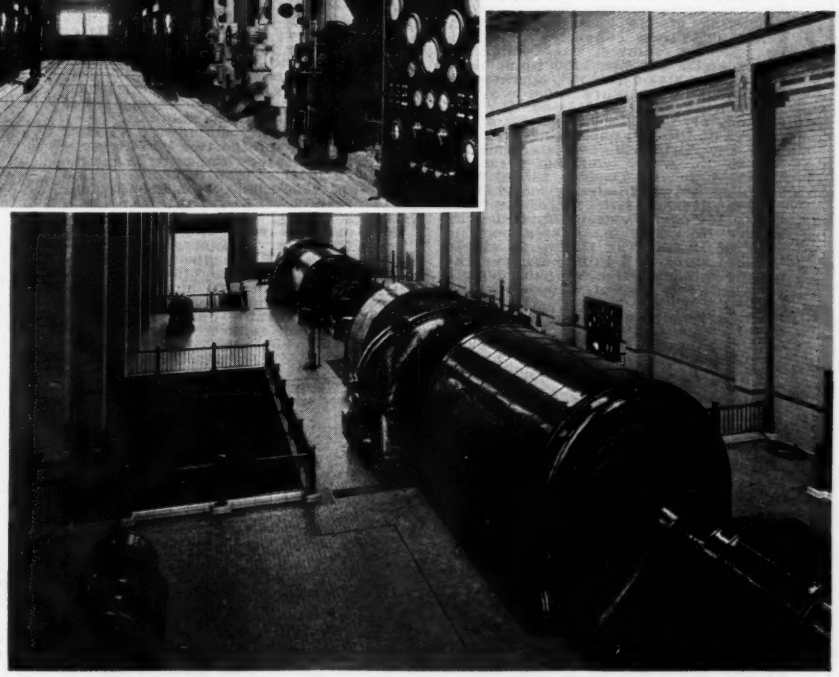


FIG. 7. THE TURBINE ROOM OF TAN AND GREEN TILE IS ONE OF THE FINEST IN THE COUNTRY

Heat Balance

Heat balance diagrams for full and 3/4 load are shown by Figs. 1 and 2. Well water stored in an outside elevated tank is used for evaporator feed. This tank in turn supplies, through a float valve, the makeup tank shown in Fig. 3. From there the flow through the blowdown heat exchanger to the evaporators is apparent from the heat balance. Evaporators which can be operated either single or double effect, receive steam from the high pressure bleedpoint, both the vapor and drains

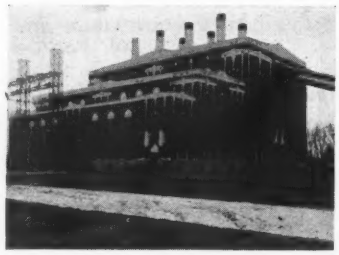
Equipment Installed In the Harding Street Plant

Location: Indianapolis, Ind.
Operating company: Indianapolis Power & Light Co.
Engineers and constructors: The Management & Engineering Corp.
Present capacity: 70,000 kw.
Ultimate capacity: 140,000 kw.

TURBINE ROOM EQUIPMENT

2 Westinghouse Electric & Mfg. Co., 36,750 kw., 1800 r.p.m., turbines, driving a 43,750-kv-a., 0.80 p.f. 3-phase, 60-cycle, 13,800-v. generator. Direct driven 2400 v. 2185 kv-a. at 0.80 p.f. 3 house generator units are excited by 20-kw., 125-v. direct driven exciters.

2 Westinghouse Electric & Mfg. Co. 175 kw., 250-v, motor generator sets. Generators driven by a 265 hp., 3-phase, 60 cycle, 2300 v., 1180 r.p.m. type CS line start squirrel cage motors.



1 Westinghouse Electric & Mfg. Co. 175 kw. dual drive emergency exciter unit consisting of 175 kw., 250 v., D. C. generator, direct connected to a 265 hp., 2300 v. squirrel cage induction motor and a 265 hp., 1180 r.p.m. noncondensing steam turbine, operated at station boiler pressure.

2 Griscom-Russell Co. 7154-sq. ft., two section, style H-K-Fin generator air coolers of the two pass design for use with raw circulating water, designed for 25 lb. water working pressure. Tubes 1 in. O. D. No. 18. B.W.G. seamless drawn Admiralty metal. This cooler will cool 380,160 lb. of air from 142 to 104 deg. F. when supplied with 532,000 lb. of 80-deg. water per hr.

2 Griscom-Russell Co. 782-sq. ft. single section, style H-K-Fin house generator air cooler of the two-pass design, designed for 25 lb. water working pressure. Tubes 1 in. O. D. No. 18 B.W.G. seamless drawn Admiralty metal. This unit will cool 46,460 lb. of air from 127 to 104 deg. F. when supplied with 79,000 lb. per hr. of raw water entering the cooler at 80 deg. F.

2 Westinghouse Electric & Mfg. Co. 33,000-sq. ft., two-pass divided water box, radial flow surface condenser, with integral cast iron baffle, built-up steam inlet, spring supported. Unit will condense with clean tubes 315,000 lb. of steam per hr. and maintain a vacuum of 27.02 in. when supplied with 33,500 g.p.m. of 80-deg. F. water.

6610—National Electric Products Corp. ⅞-in. O.D. No. 18 B.W.G., 22-ft. 1½-in. long black skin finish seamless Admiralty mixture bull dog condenser tubes. Inlet end belled, outlet end packed with 6610 Crane Packing Co. metallic packing.

2 Westinghouse Electric & Mfg. Co. 1810-sq. ft., low-pressure, horizontal, 19 stage extraction heaters, consisting of 560, ⅝-in. No. 18 B.W.G. Admiralty metal tubes. Tube sheets are of steel. Water box is designed for 125 lb. water pressure; capacity, 312,000 lb. of feed water per hr. from 94 to 154 deg. F. when supplied with steam at 4.64 lb. absolute pressure; water velocity through tubes, 3.29 ft. per sec. Pressure drop 3 lb. per sq. in.

2 Westinghouse Electric & Mfg. Co. 1400-sq. ft., high-pressure, 8 stage extraction heaters, consisting of 506 ⅝-in. No. 18 B.W.G. Admiralty metal tubes. Water box is designed for 550 lb. Capacity 392,000 lb. of feedwater per hr. from 217 to 289 deg. F. when supplied with steam at 63.1 lb. absolute pressure. Water velocity through tubes 4½ ft. per sec.; pressure drop, 4 lb. per sq. in.

2 Cochrane Corp. cylindrical horizontal open direct contact, 15 stage extraction heaters, 6 ft. in diameter by 12 ft. long, total water storage capacity of 180 cu. ft. Made of ⅜ in. Armco iron and designed for a maximum working pressure of 30 lb. Capacity 350,000 lb. of water per hr. from 173 deg. F. to a temperature within 2 deg. of the saturated temperature of the steam in the heater, approximately 16.8 lb. absolute.

2 Foster Wheeler Corp. 174-sq. ft. horizontal evaporators for first and second effect arrangement. Made up of 30 coils of 1-in. No. 16 B.W.G. seamless drawn Arsenical copper tubes. Designed for 125 lb. in the coils and 100 lb. in the shell. Double effect the unit will evaporate 11,500 lb. water per hr. from 154 deg. water when supplied with 70-lb. steam and a heat content of 1232 B.t.u. per lb.

2 Westinghouse Electric & Mfg. Co. 800 sq. ft. evaporator condensers consisting of 434, ⅝-in. O.D. No. 18 B.W.G. by 11 ft., 6 in. Admiralty metal tubes expanded at both ends. The evaporator condenser in condensing 17,000 lb. per hr. of 179 deg. F. saturated vapor will heat 348,000 lb. per hr. of feedwater from 154 to 173 deg. F. Pressure loss 3.5 lb.

2 Westinghouse Electric & Mfg. Co. steam jet air evactors. Cooling surface of 156 sq. ft. consists of three passes of condensate and one pass of raw water. Ejector requires 120 g.p.m. of raw cooling water. Drop through condensate section 1.95 ft. through raw water sections 0.65 ft. Capacity at 29 in. vacuum, 40 cu. ft. of 70 deg. F. free air per min. Evactor provided with air metering device.

6 Westinghouse Electric & Mfg. Co. two-stage condensate pumps. Capacity of 400 g.p.m. each against a total discharge head of 150 ft. Pumps driven by a 50-hp., 1160-r.p.m., 2300-v., squirrel cage motors.

6 Atwood-Morrill heater drainers.

2 American Steam Pump Co. duplex vertical bilge pumps, for condenser pits. Capacity, each, 150 g.p.m. Driven by a 3-hp., 1750-r.p.m. motor.

2 American Steam Pump Co. heater drain pumps for the two low pressure extraction heaters. Capacity 75 g.p.m., 88½ ft. head. Pump directly coupled to 5-hp., 1750-r.p.m., 3-phase, 60-cycle, 440-v. motor.

2 Ingersoll-Rand Co. size 1½-in. type RV, make-up water pumps, capacity each 50 g.p.m., against an 85 ft. discharge head. Pump direct coupled to a 3-hp., 3500-r.p.m., 440-v., 3-phase, 60-cycle squirrel cage motor.

1 Nash Engineering Co. size V-20, electric driven vacuum pump for heating system, direct connected to a 1-hp., 3-phase, 60-cycle, 440-v. motor. Capacity 10,000 sq. ft. of direct radiation.

1 Manning, Maxwell & Moore, Inc. four motor electric travelling crane, 75-ton capacity with 10-ton auxiliary hoist, 62 ft. lift, 55 ft. span.

1 Worthington Pump & Machinery Corp. 12 by 7½ by 9-in. Laidlaw duplex, two stage, 125-lb. air compressor, driven by a 60-hp. motor. Displacement of 350 c.f.m. at 300 r.p.m.; actual capacity, 298 c.f.m.; volumetric efficiency 85 per cent.

1 Worthington Pump & Machinery Corp. 8½ by 9-in., 100-lb. single stage air compressor, driven by a 25-hp. motor, 1200-r.p.m., 440-v.; piston displacement, 174 c.f.m. at 300 r.p.m.; discharge pressure 100 lb. Actual capacity 118 c.f.m., volumetric efficiency 68 per cent.

2 S. F. Bowser & Co. No. 16, type A, turbine oil filters, having a capacity of from 500 to 1000 g.p.h. of oil. Oil trays have an area of 120 sq. ft. and the clean oil compartment holds 348 gal.

1 S. F. Bowser & Co. 4000-gal. dirty precipitating tank to serve both units, consisting of two 2000 gal. compartments.

2 S. F. Bowser & Co. ¾-in. rotary oil pumps, capacity 8 g.p.m., for continuous circulation of oil from each filter to each turbine. Pump driven by a ¾-hp., 440-v., 1200-r.p.m. motor.

1 S. F. Bowser & Co. 2-in. rotary oil pump for filling up turbine, capacity, 75 g.p.m.; driven by a 5-hp., 440-v., 1200-r.p.m. motor.

1 Consolidated Engine Stop Co. automatic vacuum tripper.

BOILER ROOM EQUIPMENT

8 Springfield Boiler Co. 11,810-sq. ft. boilers, for 450 lb. working pressure. Max. cap. 190,000 lb. of steam per hr. normal capacity, 124,000 lb. of steam per hr.

8 Westinghouse Electric & Mfg. Co. 10-retort, new model, underfeed stokers, each equipped with link grate overfeed sections and double roll clinker grinder. Stoker driven through Multi-V drive by 15-hp. infinitely variable General Electric type B.T.A., 440-v. motor, having a speed range of from 550 to 1650 r.p.m. The actual area of the fuel supporting surface of each stoker is equivalent to 372.07 sq. ft. Projected grate area 348.61 sq. ft. Stoker is approximately 19 ft., 8¾ in. deep by 17 ft., 8¼ in. wide. Coal burning at max. boiler capacity 23,350 lb. per hr.; at normal steaming, 14,540 lb. per hr.

8 Superheater Co. Elesco interdeck superheaters, each consisting of approximately 2540 sq. ft. of heating surface. To raise the temperature of steam to 725 deg. F. when the boiler is delivering steam to superheater at a pressure of 440 lb. per sq. in. at the rate of 124,000 lb. per hr. Pressure drop through superheater at this rate 11 lb. Draft loss 0.07 in.

8 Air Preheater Corp. Ljungstrom air heaters, each having heating surface of 17,800 sq. ft. to raise the temperature of 176,000 lb. of air per hr. from 80 to 311 deg. F. when supplied with 190,500 lb. of flue gas per hr. entering the preheater at 490 deg. F. and leaving the preheater at 278 deg. F. The resistance through both the gas and air side is 1.05 in. Preheaters driven through.

8 W. A. Jones Fnd. Mach. Co. worm speed reducer by a 2-hp., 440-v., 1800-r.p.m. motor.

8 Foster Wheeler Corp. 5760-sq. ft. counter current flow economizers, each economizer being 12 rows high by ten rows wide with elements 16 ft. long to heat 124,000 lb. of water per hr. from 290 to 374 deg. F. when 176,000 lb. of flue gas per hr. is passed through the economizer with a temperature at entrance of 735 deg. F., draft loss through economizer 1.58 in. Water pressure drop through economizer 15.9 lb.

8 Drake Non-Clinkering Furnace Block Co. suspended air-cooled walls, each side wall containing 140 sq. ft. and the front wall containing 108.5 sq. ft., giving a total of 388.5 sq. ft.

8 Drake Non-Clinkering Furnace Block Co., water cooled furnace lining, consisting of 88½ sq. ft. of Armor Clad tubes for each side wall, 177½ sq. ft. of Thermo fit blocks for rear walls and 252 sq. ft. of bare tubes. In addition to this, there are auxiliary side wall tubes consisting of 116 sq. ft. area per side, making a total of 838½ sq. ft. Side wall tubes seven rows high, 4 in. diameter No. 6 B.W.G. tubes on 8-in. centers. Bridge wall consisting of 40 3-in. diameter No. 8 B.W.G. seamless tubes and auxiliary walls consisting of bare seamless tubes, 4 in. in dia. No. 6 B.W.G.

4 Boilers equipped with Vulcan Soot Cleaner Co. soot cleaners.

4 Boilers equipped with Diamond Power Specialty Co. soot blowers.

8 International Filter Co. type PCT internal steam purifiers.

8 Buffalo Forge Co. No. 11 super-duplex induced draft fans with dual motor drive, one motor being 250 hp., 865 r.p.m. and the other 100 hp., 570 r.p.m.; both motors, 2300-v., 3-phase, 60-cycle; maximum capacity, 110,720 cu. ft. of 313-deg. F. flue gas per min. against 8.5 in. static head. Static efficiency 65 per cent. Mechanical efficiency 75 per cent.

8 American Blower Co. No. 7 double inlet, double width, series 30, high speed, forced draft fans with dual motor drive, one motor being 125 hp., 1165 r.p.m. and the other 50 hp., 860 r.p.m., both motors 2300 v. Maximum capacity 66,600 cu. ft. of 80 deg. F. air per min. against a total static head of 6.9 in. Static efficiency 70 per cent. Mechanical efficiency of 77.5 per cent.

3 Dean Hill Pump Co. 4-in., 8-stage centrifugal boiler feed pumps; capacity 400 g.p.m. of 236 deg. F. water against a discharge head of 575 lb. pressure with 10 to 23 lb. absolute pressure at suction of pump; 2 pumps direct connected to a 200-hp., 1750-r.p.m., 2300-v. motor and one direct connected to Westinghouse type 4 AMD impulse type, 1750-r.p.m. turbine for operating

Equipment Installed In the Harding Street Plant

at 400-lb. steam 700 deg. total temperature with 5 to 23 lb. abs. back pressure.

3 Allis-Chalmers Mfg. Co. 5-stage centrifugal boiler feed pumps; capacity, 400 g.p.m. of 236 deg. F. water against a total dynamic head of 1370 ft., 2 pumps direct connected to a 200-hp., 3500 r.p.m., 2300-v. motor and one direct connected to a Westinghouse type 3 AMD impulse type, 3500-r.p.m. turbine for operating at 400-lb. steam, 700 deg. F. total temperature with 5 to 25 lb. absolute back pressure. Pump efficiency 70 per cent.

1 Allis-Chalmers Mfg. Co., type S.G., 1750-r.p.m. centrifugal pump for supplying water to Hydrovactor required for vacuum cleaning system. Capacity 650 g.p.m. of water against a total head of 81 ft. Pump direct connected through flexible coupling to a 20 hp., 1750 r.p.m., 440 v. squirrel cage motor. Efficiency 78 per cent.

1 Allen-Sherman-Hoff Co., vacuum cleaning system, complete with Hydrovactor, nozzles, brushes, inlet valves and 150 cu. ft. steel receiving tank.

1 Hagan Corp. combustion control system for controlling the four boilers required for Unit No. 1.

1 Leeds & Northrup Co. system of combustion control for controlling the four boilers required for unit No. 2.

2 Swartwout Co. heat exchangers, built in three sections and having a capacity to cool 2040 lb. of blow down water from 460 to 110 deg. F.; when using as a cooling medium, 11,370 lb. of cooling water per hr. Cooling water to enter heat exchanger at 100 and leave at 165 deg. F. Each heater will contain 60 sq. ft. heating surface, made of 1¼-in. O.D. No. 13 gage steel tubing; tubes designed for 460 lb. working pressure. Shell for 100 lb.

CRIB HOUSE EQUIPMENT

4 Westinghouse Electric & Mfg. Co. vertical, propeller type circulating pumps, each having a capacity of 17,500 g.p.m. against a 24-ft. discharge head and driven by a 150-hp., 2300-v., 1160-r.p.m., vertical squirrel cage motor.

2 Allis-Chalmers Mfg. Co. 4 by 3 in., screen wash pumps; capacity, 400 g.p.m. against a head of 225 ft. Connected through a flexible coupling to a 40-hp., 3500-r.p.m., 440-v. motor; pump efficiency, 73 per cent.

1 American Steam Pump Co., 150 g.p.m. bilge pump, pump direct connected to a 3 hp., 1750 r.p.m. motor.

1 American Steam Pump Co., size 1-in., type HBM centrifugal water booster pump, to be used in connection with chlorination equipment. Pump driven by a 3 hp., 3450 r.p.m. motor. Capacity 40 g.p.m. against head of 106 ft.

1 Paradon Mfg. Co. chlorinator, type DBMI for treating condenser circulating water, guaranteed to satisfactorily apply chlorine in amounts up to 300 lb. per 24 hr. against a pressure not greater than 30 lb. per sq. in.

4 Link Belt Co., 94-in. wide, model E, vertical traveling refuse screens for water intake pits, 29 ft. deep. Screens driven through speed reducers by 5 hp., 1760 r.p.m. motor.

4 Chapman Valve & Mfg. Co. 48 by 48-in. spigot frame sluice gate valve with floor stand.

COAL HANDLING EQUIPMENT

1 Link-Belt Co. coal handling system, having a capacity of 250 t. of coal per hr. and consisting of the following:

36-in. wide troughing belt conveyor for transferring coal from gantry crane to belt conveyor No. 2 to operate at a belt speed of 300 ft. per min. and provided with 36 in. wide, six-ply, 28-oz. duck and driven through speed reducer by 10-hp., 1200-r.p.m., 440-v. motor.

36-in wide automatic, double reciprocating feeder for transferring the coal from double track hopper to belt conveyor No. 2 and driven through speed reducer by 15-h., 1200-r.p.m., 440-v. motor.

36-in wide troughing belt conveyor for delivering coal from track hopper to crusher, to operate at a belt speed of 300 ft. per min. and driven through speed reducer by 15-hp., 1200-r.p.m., 440-v. motor. A 30-in. dia. magnetic head pulley is used in connection with this conveyor.

30-in. wide troughing belt conveyor for conveying the coal from crusher house to the coal bunkers. Conveyor to operate at a belt speed of 400 ft. per min. and is provided with 6 ply, 32 oz. duck belting. A self-propeller belt tripper is provided above the coal bunkers for distributing the coal; belt conveyor driven through speed reducer by 50-hp., 1200-r.p.m., 440-v. motor.

3 U. S. Rubber Co. Security Brand conveyor belting for above conveyors.

1 Dings Magnetic Separator Co., magnetic head pulley 30 in. dia.

1 American Pulverizer Co. No. 42-S ring crusher, having a crushing capacity of 250 t. of run-of-mine bituminous coal per hour and crushing it down to 1¼ in. and under and direct driven by a 100-hp., 2300-v., 600-r.p.m. motor.

1 Charleroix Iron Wks. automatic coal sampler.

16 Richardson Scale Co. automatic coal scales of a belt feed, type J-55, two scales required per boiler. Each scale has a normal capacity of 6 t. of coal per hour and is equipped with ½-hp., 440-v. motor.

1 Merrick Scale Co. type E, Weightometer to operate on 36-in. belt.

16 Rolland Gardner & Co. Non-Seg coal distributors.

16 Henry Pratt Co. 14-in. square dustless coal valves, two required for each boiler.

1 Link-Belt Co. gantry crane for coal storage pile, having a capacity of 250 t. of coal per hour, using a 3½-t. bucket.

1 H. K. Porter Co. four-wheel connected fireless steam locomotive.

2 American Steam Pump Co., bilge pumps for track hopper and crusher house basement. Capacity 150 g.p.m. Driven by a 3-hp., 1750-r.p.m. motor.

ASH HANDLING EQUIPMENT

1 Hydro Ash Corp. ash sluicing system consisting of liner plates for ash hoppers, one 24 by 30-in. hydraulically operated ash discharge gate for each boiler, ash discharge manifolds for washing the ashes from the hopper at a uniform rate, trench liners, 24-in. cast-iron cover plates

1 American Pulverizer Co. ring crusher clinker grinder, capacity 60 t. of ash per hr. and direct connected to a 15-hp., 720-r.p.m., 440-v. motor.

2 Morris Machine Works vertical centrifugal ash pumps; capacity, each, 1800 g.p.m., head 100 ft.

2 American Steam Pump Co. 6-in., centrifugal ash sluicing pumps, direct connected to 200-hp., 2300-v., 1750-r.p.m. motors; capacity, 1425 g.p.m.; 360 ft.

MISCELLANEOUS

1 Pittsburgh-Des Moines Steel Co., 50,000-gal., 125-ft. high water tank with 48-in. riser pump.

1 Hall Laboratories, Inc., system of feed water treating for treating feedwater.

2 International Filter Co. style R, 60-in. filters with No. 3 coagulant feeder for drinking water system.

1 International Filter Co. Inflico coke tray type drinking water aerator with collecting pans. Capacity 150 g.p.m.

2 Elliott Co. 6-in., type F Single Basket strainers for screen wash pumps.

1 Elliott Co. 14-in., type R Twin Basket strainers for ash cluicing pumps.

2 Blackburn-Smith Corp. strainers.

2 Fisher Gov. Co. Type 235, remote style condensate control valves.

High pressure gate valves: Walworth Co.

Low pressure gate valves: Walworth Co.

High pressure forged steel valves: The Edward Valve & Mfg. Co.

Boiler blow off valves: The Edward Valve & Mfg. Co.

Boiler non-return valves: Crane Co.

Reducing valves: Swartwout Co.

Bleeder check valves: Atwood & Morrill.

Power control valves: Swartwout Co.

Circulating water valves: Chapman Valve & Mfg. Co.

Feed water regulating valves: Swartwout Co.

Differential pressure valves for feedwater system: Swartwout Co.

Boiler feed relief valves: Swartwout Co.

Radiator valves: Warren-Webster Co.

Radiator traps: Warren-Webster Co.

Atmospheric relief valves: Atwood & Morrill.

Steam strainers: Atwood & Morrill.

Duct work insulation: The Philip Carey Co.

Piping insulation: Johns-Manville Corp.

Gage glasses for tanks: Crane Co.

Unit heaters: L. J. Wing Mfg. Co.

Drainage control system: Swartwout Co.

Miscellaneous float control boxes: Swartwout Co.

Cast iron circulating water piping: Pittsburgh Piping & Equipment Co.

Underground, service and drinking water piping: James B. Clow & Sons.

Expansion joints: Joseph Kopperman & Sons, Rub-Tex Products Co.

Steam traps: Barrett-Christie Co., Swartwout Co.

Evaporator control valves: Swartwout Co.

Priming ejectors for circulating pumps: Elliott Co.

Protective coating: Dampney Co.

Tube cleaners: Lagonda Mfg. Co.

Water columns: Yarnall-Waring Co.

Boiler gage glasses: Reliance Gage Col. Co.; Yarnall-Waring Co.

Boiler firebrick: General Refractories Co.; Pyro Clay Product Co.

Refractory cement: Sayre-Fisher Brick Co., Firetite Products Corp.

Boiler wall coating: Fire and Weather Insulating Co.; Republic Paint & Varnish Co.

Air-Cooled side wall insulation: Insulating Product Co.

Flues, uptakes, air ducts: Connery Co.

Ash discharge piping: United Conveyor Corp.

Passenger elevator: Westinghouse Electric & Mfg. Co.

Hydraulic lift: Gallaher & Speck Co.

Cork for turbine foundation: Cork Foundation Co.

Pressure gages: Consolidated Ashcroft Hancock Co.

Recording thermometers: Consolidated Ashcroft Hancock Co.

Flow meters: Republic Flow Meters Co.

Turbine manometers: Taylor Instrument Co.

Barometers: Consolidated Ashcroft Hancock Co.

Moisture indicator for generator air ducts: Moisture Indicator Co.

Conductivity recorder: Esterline-Angus Co.

Generator temperature recorder: Leeds & Northrup Co.

Turbine vacuum and barometer recorder: Uehling Instrument Co.

Fire protection for generator: Walter Kidde & Co.

Indicating thermometers: Consolidated Ashcroft Hancock Co.

Draft gauge: Ellison Draft Gauge Co.

Water level recorders: Foxboro Co.

CO_2 recorders: Republic Flow Meters Co.

Vibrating tachometers: James G. Biddle Co.

Structural steel: Hetherington & Berner, Inc.

Window Sash: Truscon Steel Co.

Roofing: Johns-Manville Corp.

ELECTRICAL

Electrical list will be given in the Mar. 1, 1932, issue.

CONTRACTORS

Steel erector: R. H. Goodrich Co.

High-pressure piping furnished and erected by R. H. Baker Co., Inc.

Low-pressure piping furnished and erected by Pittsburgh Piping & Equip. Co.

Pipe covering furnished and installed by W. S. Hamilton Co.

being carried to the evaporator condenser located between the No. 1 and 2 extractor heaters. Immediately below the evaporator is a storage tank for distillate. Evaporated makeup is introduced into the system from the storage tank to the low pressure or No. 1 heater through a float valve controlled by the level in No. 2, an open heater using steam from the intermediate bleed point.

Boiler feed pumps take their suction from the open heater and pump through the No. 3 heater to the economizer. At full load on the turbine and normal load on the boilers water enters the economizer at 290 deg. F.

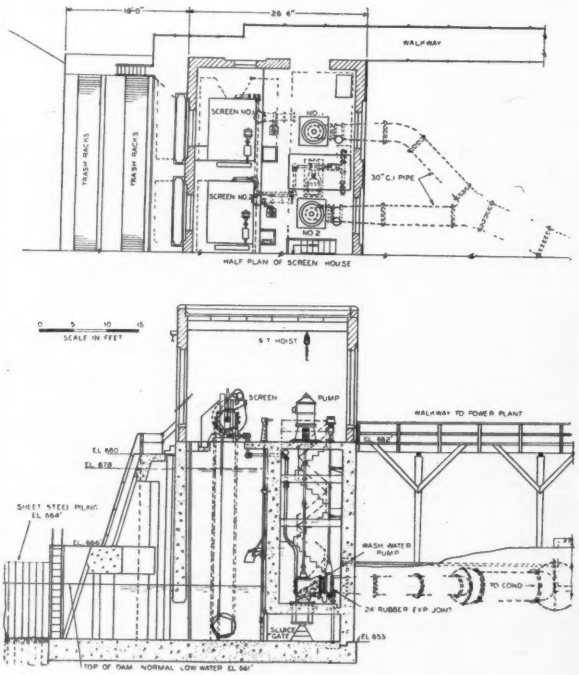


FIG. 8. VERTICAL CIRCULATING PUMPS ARE LOCATED IN A SEPARATE SCREEN HOUSE

and the boiler at 374 deg. F. Three boiler feed pumps, two motor and one turbine driven, are supplied for each section of four boilers. Each pump has a capacity of 400 g.p.m. at 1370-ft. head. Location of these pumps in the bay between the turbine room wall and boiler is shown by Figs. 3 and 4. By way of explanation, referring to the heat balance diagram, the reader may wonder why the quantity of water entering the boilers is so much greater than the sum of the steam generated and water blown down from the boilers. The reason for this is that the steam loss due to operation of soot blowers is not shown on the diagrams and that a rather liberal figure for make-up water was assumed in the heat balance calculation.

Auxiliary Power Supply

With the exception of the two turbine driven boiler feed pumps, and one dual drive exciter set, all auxiliaries are motor driven by 2300 and 440-v. across-the-line-starting motors. Motors of 50 hp. and over operate at 2300 v. and smaller motors at 440 v. Normally, auxiliary power is supplied by the 1750-kw. shaft driven house generators, although auxiliary power is available in emergencies from a bank of 132,000/2300-v. transformer bank connected to the 132,000-v. bus. Excitation is by means of individual 175-kw. motor generator sets or in emergencies from a 175-kw. dual drive unit which can be used on either unit. In normal operation, each main generator, four boilers and auxiliaries are operated as a unit.

The building itself, of brick, steel, concrete and tile construction, is built in three sections and rests on approximately 1600 white oak piles with 85 under each turbine unit. The piles are topped with a concrete mat, bringing the basement floor approximately 12 ft. below high water level and 5 ft. above the top of the fixed dam. The area immediately surrounding the plant and including the railroad tracks, roadway and switchyard has been filled to approximately 4 ft. above high water.

Not only is the architectural treatment of the plant exterior unusually fine but the interior of tan tile with green trim sets a new standard of turbine room decora-

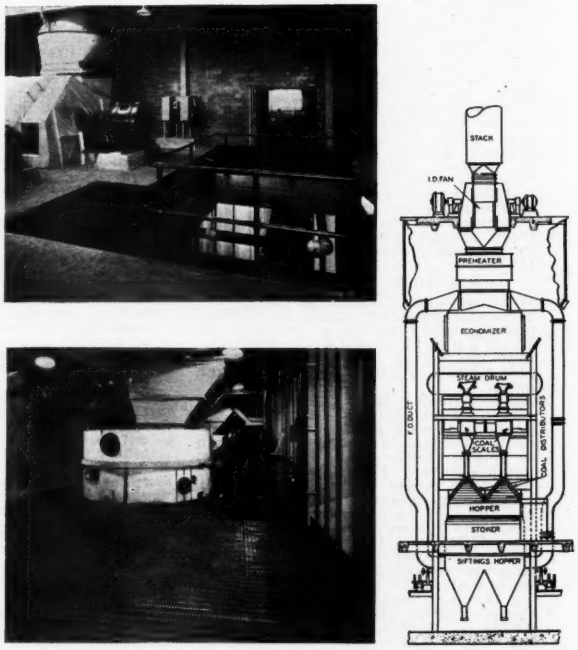


FIG. 9. INDUCED DRAFT FAN AND AIR PREHEATER FLOORS AND ELEVATION OF THE BOILER SHOWING ARRANGEMENT OF EQUIPMENT

tion combining harmony of color and simplicity in a manner yet to be equalled.

As can be seen from Fig. 3, the building is divided into three sections of different heights; the switch and control room, turbine room and boiler room areas and volumes including the basement are as follows:

Switch Room	4,594 sq. ft.	295,080 cu. ft.
Turbine Room	10,595 sq. ft.	788,675 cu. ft.
Boiler Room	18,803 sq. ft.	2,131,100 cu. ft.
Total	33,992 sq. ft.	3,214,855 cu. ft.
Screen House	1,269 sq. ft.	59,690 cu. ft.

The main entrance to the building is at the northeast corner. Offices are in this wing over the switch room with the control room southeast corner of the present section. This will, of course, be midway of the final section between No. 2 and 3 turbines. Further details of the electrical features will be given in a subsequent article.

Standard Symbols for Power Plant Diagrams

FLOW AND HEAT BALANCE DIAGRAMS SIMPLIFIED BY GRAPHICAL SYMBOLS RECOMMENDED BY INTERNATIONAL ELECTROTECHNICAL COMMISSION

FOR MANY YEARS more or less conventional symbols have been used on the Continent to represent equipment in power plant diagrams. Recently this system was adopted by the International Electrotechnical

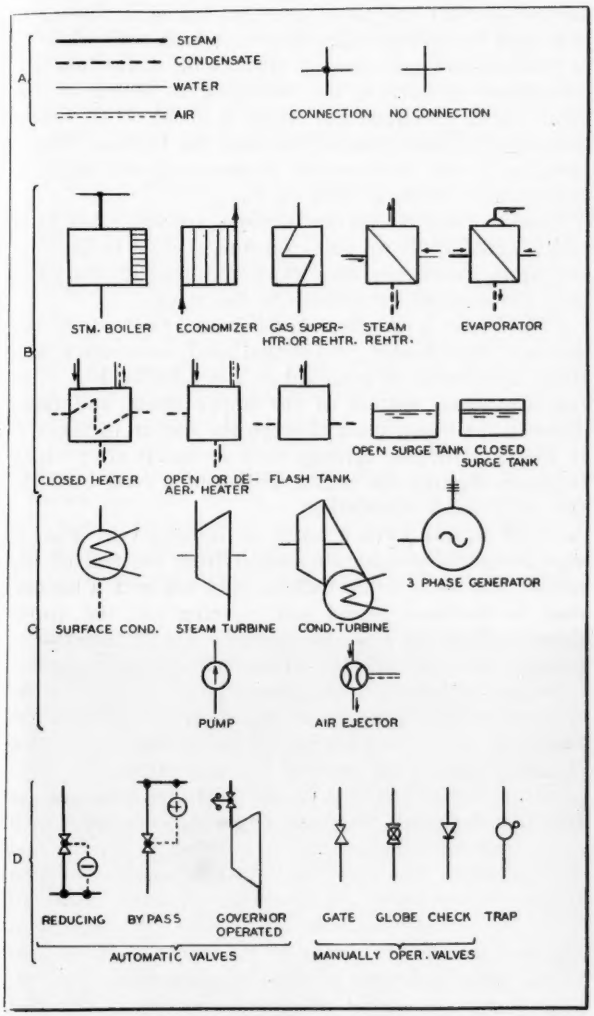


FIG. 1. STANDARD SYMBOLS FOR DIAGRAMS

Commission, presumably in hopes that the practice would gradually come into general use.

Considering the wide variety of equipment in use in this country and the freedom which has been allowed designers in following their inclination with diagrams, it is doubtful whether the standard symbols will be adopted in their entirety for many years.

There are, however, certain conventions such as valves and piping which can be used to advantage without interfering in any way with the individuality of diagrams. For instance, as shown by Fig. 1A, steam lines are represented heavy solid, condensate dotted, water light solid and air by a double line. Lines which cross on the diagram are connected only when a circle is used at the intersection.

For the balance of the system, three general symbols are used: squares represent steam generators and heat exchangers; circles represent condensers, generators and pumps and trapezoids, prime movers. In Fig. 1B are shown four types of heat exchangers, i.e. boilers, superheaters, reheaters and feedwater heaters. To the symbols recommended by the committee have been added the air heater, economizer, open heater, evaporator and flash tank to make the series complete. With the air vent omitted, thoroughfare steam reheaters can be represented as closed heaters.

Condenser turbines and generators are represented as shown in Fig. 1C and various types of valves by Fig. 1D. To the first three as recommended by the committee have been added four more, the gate valve, globe valve, check valve and trap or drainer. This list could be extended indefinitely (as outlined more in detail in discussing German practice, p. 532, May 1, 1929) but the symbols shown will in general cover the average diagram.

In order to illustrate the use of these symbols, the heat balance diagram for Harding St. Station (on page

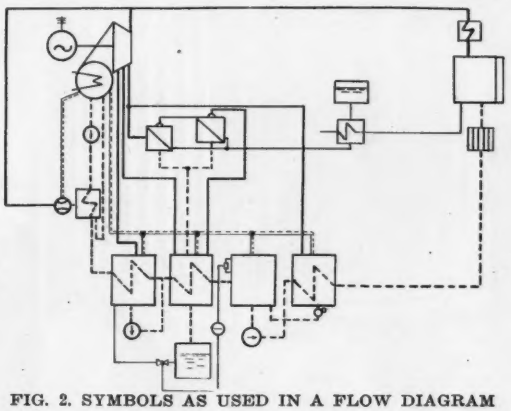


FIG. 2. SYMBOLS AS USED IN A FLOW DIAGRAM

152 of this issue) has been redrawn using the standard symbols as shown by Fig. 2. At first glance, one may well wonder whether the symbols are a simplification. It is well to remember, however, that symbols have been well standardized and used in electrical diagrams for many years. The value and success of such standardization is shown by the universal use made of it in the electrical industry.

NEW YORK University Heating & Ventilating Engineers Society will hold its annual Dinner, Dance and Entertainment at the Hotel Taft, 50th St. and 7th Ave., New York City, on Saturday, February 20. Inspection tours are arranged and conducted once each month by the Society for educational purposes. Engineers and student engineers are cordially invited to attend these inspection trips. Further data may be obtained from T. J. Berk, Secretary, 210 W. 105 St., New York.

SPECIFICATIONS for five different types of pipe have been accepted and published in tentative form by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa. These cover electric fusion welded steel pipe, designation A 134-31T; electric resistance welded pipe, designation A 135-31T; forge welded steel pipe, designation A 136-31T; lock bar steel pipe, designation A 137-31T and riveted steel and wrought iron pipe, designation A 138-31T.

POWER PLANT ENGINEERING February 15 1932

Caron Spinning Co. Installs New Type Boiler

TWO DRUM DESIGN WITH WATER-COOLED FURNACE
RATED AT 22,000 LB. PER HR. OF 150 LB. GA., 500 DEG. F.
STEAM DESIGNED PRIMARILY FOR LOW HEAD ROOM

PERHAPS the most interesting boiler development of the year, particularly for small or medium sized plants, is the new boiler installation of the Caron Spinning Co., at Rochelle, Ill. This company, maker of worsted yarn, has a more or less constant steam load of about 10,000 lb. per hr. for power generation upon which is super-imposed during the day, an extremely variable

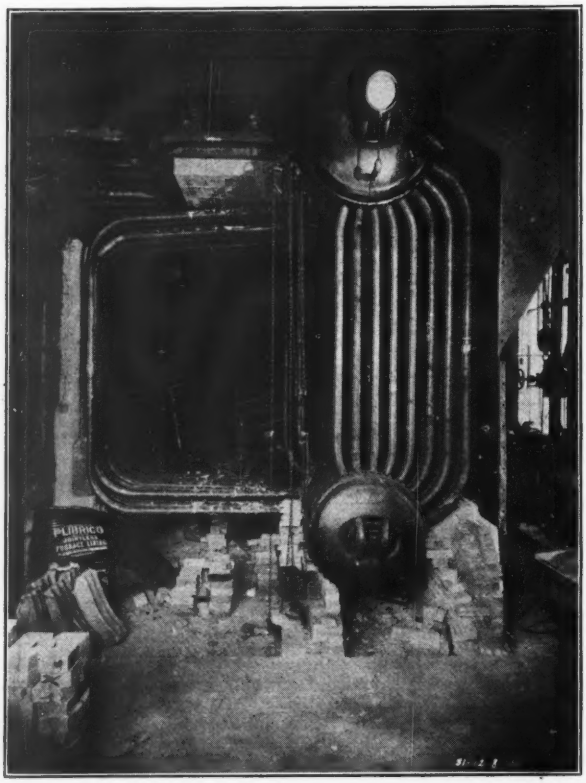


FIG. 1. VIEW FROM THE FIRING END DURING CONSTRUCTION. BURNER FIRES DOWN THE WATER COOLED SECTION AT THE LEFT. GAS RETURN THROUGH THE CONVECTION SURFACES AT THE RIGHT

dye house and process load ranging from 0 to a maximum of 15,000 lb. per hr.

In order to get additional steam generating capacity at higher efficiency the company recently replaced one hand-fired h.r.t. boiler with a pulverized fuel unit of unusual and promising design. This boiler, known as the S & G steam generator* is a low head room, two drum bent tube unit of unconventional design with a heating surface of about 3000 sq. ft. about 40 per cent, on a total tube surface basis, being radiant and 60 per cent convection surface. One of the interesting features of the installation is the fact that it was installed in the same space and uses the same supports as the h.r.t. boiler it replaced.

*Designed by K. C. Schmidt, Freeman Boiler & Eng. Co., Chicago.

As can be seen from Fig. 1, the two outside rows of tubes have been extended about 7 ft. to make a water-cooled furnace about 7 by 9 ft. in cross section. The unit is fired by a single pulverized coal burner located so that the flame and gas travel is down the center of the radiant furnace to the back wall where it is reversed and continues on through the convection and economizer sections to the breeching as shown by the plan Fig. 2. Average gas travel is about 30 ft. before entering the convection section and the furnace volume included in the water-cooled furnace and rear combustion chamber is about 2180 cu. ft.

Radiant and convection sections are separated by a longitudinal baffle or partition and a cross baffle from the upper drum prevents short-circuiting of the gases past the economizer sections to the stack.

The boiler is in effect divided into four parts: the radiant, superheater, convection and economizer sections. Feedwater is admitted to a box baffle, Fig. 2, in the economizer section of the upper drum and flows down to the lower drum through the section of tubes A in Fig. 2, returning through tube section B after which it passes through the cutout section of a cross baffle to the main boiler circulation.

Both drums have a baffle as indicated in Fig. 2, separating the economizer section from the rest of the boiler. The lower drum baffle is solid but with a latched door to facilitate access and cleaning but the upper drum baffle is cut away as shown by Fig. 3. Feedwater passes freely through the submerged cut away section but steam returning to the conventional dry pipe in the economizer end of the drum passes through slots in the partition. These slots are backed by sections of deep leg channels forming an integral steam separator.

Air for combustion is drawn under the floor, up the side and rear walls and back across the suspended arch to the pulverizer giving 200 to 250 deg. F. air for coal drying. With the exception of the three-foot section forming a refractory ignition arch all walls, floor and arch are either water or air cooled. Walls of this ignition section are battered to reflect radiant heat to the tubes and thus prevent reverberation. The setting is steel cased and thoroughly insulated. Panelled wall sections make it possible to remove tubes without disturbing any other tube or other sections of the walls or baffles. Plibrico has been used for all furnace walls.

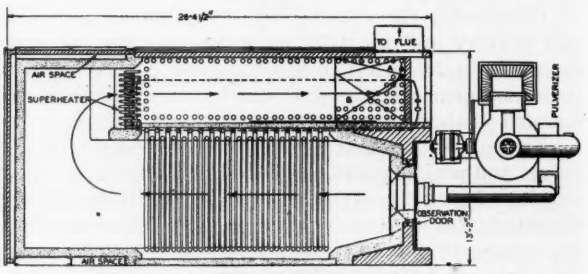


FIG. 2. PLAN OF BOILER AND SETTING

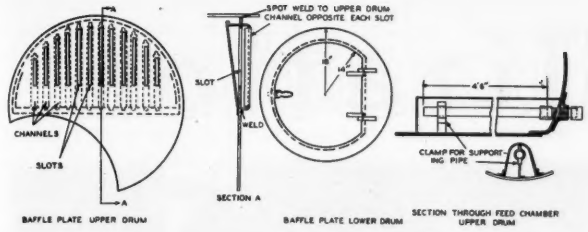


FIG. 3. DRUM BAFFLES AND SEPARATOR

The pulverizer is a Strong-Scott Unipulvo with a maximum capacity of about 2300 lb. of coal per hour. At present Franklin county 1½-in. screenings are being burned. A single Marion soot blower element running longitudinally of the convection section effectively cleans the tubes.

This particular unit has been operating at an average rating of about 200 per cent and with peaks of about 250 as measured by a Republic steam flow meter. Exit gas temperatures range from 450 to 485 deg. F. and CO_2 as measured by Hays instruments ranges around 13 per cent. This is about 100 deg. F. lower in temperature and about 5 per cent higher in CO_2 than was obtained with the previous h.r.t. unit. Complete tests have not yet been made but coal consumption of the plant has decreased noticeably, a car of coal now lasting about 5 days instead of 4 days. Operating conditions are 150 lb. g. total temperature 500 deg. F. and experience shows that the 150-sq. ft. superheater located where it is with both radiant and convection effect gives good steady temperature regulation at all loads.

Control instruments and soot blower are mounted on a steel panel formed by the pilaster like casing covering the drum end. Figure 4 shows the boiler room before the steel panel was installed. Overall dimensions of 13 ft. 2 in. wide, by 14 ft. 9½ in. high by 26 ft. 4½ in. long were dictated largely to conform with the existing equipment. The space required is exceptionally small for a unit of this size.

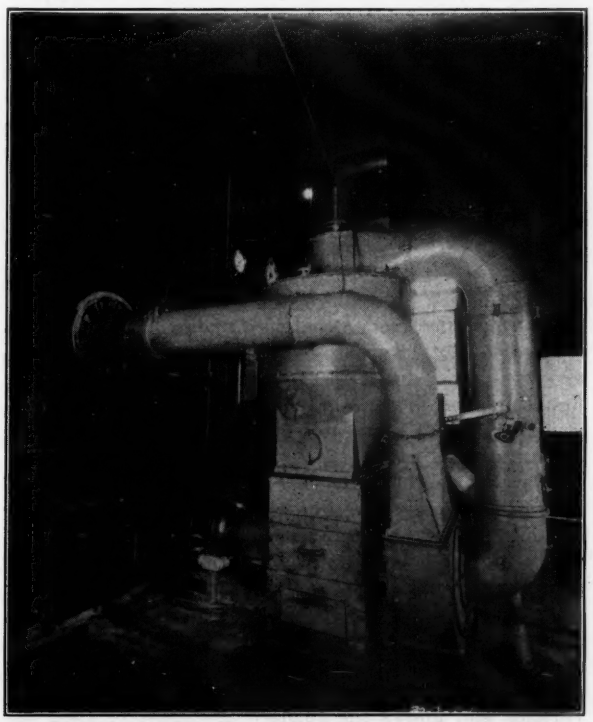


FIG. 4. FRONT VIEW SHOWING THE UNIPULVO AND ABOVE IT THE PREHEATED AIR DUCT

Although this boiler was designed for pulverized coal, gas or oil firing it can be adapted to stoker firing by adding a low bridge wall and water wall header on the front ovenside section. The capacity range of the design is from 500 to 3000 developed boiler horsepower.

Primary purposes of this boiler design were to permit greater capacity with lessened head room, to provide a water-cooled furnace and increased radiant heat absorbing surfaces without expensive water wall and header construction to provide an adequate furnace and greater length for flame travel.

Oil Engine Power Cost

INFORMATION collected by the American Society of Mechanical Engineers on oil engine power cost includes reliable and comprehensive data covering several years of oil engine operation.

Early in its history the subcommittee found that it had to undertake considerably more than the soliciting and subsequent tabulating of data. Due to the lack of a uniform practice for the reporting of data, there was initially a great amount of overlapping and conflict between plants on operating cost catagories and no general acceptance of definitions for determining such items as "peak load," "type of service," "liner wear." Standards have been set up from time to time therefore, and the latest questionnaire (covering 1931 power cost), which is now being mailed to operators of Diesel stations, repeats definitions of type of service, net output, liner wear, peak load, attendance and superintendence cost, supply cost, miscellaneous cost, repair cost, type of cooling water system, invested cost.

While the questionnaire can be completely answered by an operator keeping only the best of records, a distinction is made between essential cost questions and non-essential operational ones, by printing the former in bold face type.

The Subcommittee's work has a threefold result. The first is education of operators. Increase in number of questions answered and in the precision of the answers testifies to this. The second phase is the information furnished on power cost. In the third place, the reports supply information on operation, such as data on fuel and lubrication economy.

The subcommittee has no bias in the matter of selection of plants for listing. The only requirement is that data be sufficient to allow the calculation of power cost. Although the mailing list now includes over 1000 plants, there are no doubt many that are not receiving questionnaires. This omission is not due to any discrimination but rather to incomplete information on existing plants. Any operator of an oil engine plant which generates electric power is eligible and requests from such for questionnaire forms are always welcome. Write to the Secretary of the Subcommittee on Oil Engine Power Cost, M. J. Reed, Room 1710, 30 Church St., New York City.

POWER PLANT ENGINEERING February 15 1932

Power Utilization

Distribution of Pulverized Fuel for Metal Working

By Frank S. O'Neil

Pulverizing Plant with Distribution Signal Board at Left

IN THE accompanying drawing is shown the general arrangement of the various units and the equipment as recently installed by the Whiting Corpn., Harvey, Ill., at the Ewart Plant of Link-Belt Co. in Indianapolis. All of the furnaces, ovens and boilers were already in use, pulverized coal being applied to old equipment with few changes and without interruption to plant schedules. The system is so designed and arranged that future additions can be made without disturbing the main system or losing any part of the present equipment.

Incoming Coal

Coal drops from the incoming car to a receiving hopper underneath the switch track, whence an inclined steel apron conveyor carries it to the Link-Belt double-roller crusher in the preparation building. This crusher has a capacity of 36 t. per hour.

Crushed coal, reduced to 1¼-in. lumps drops into a Link-Belt bucket elevator, which carries it to the concrete storage silo of 700 t. capacity from which it is fed by a gravity chute into the kiln roller mill, where it is pulverized and dried at the same time, air for drying the coal being heated in a separate oil-fired heater to 300 deg., which gives a temperature of from 110 to 150 deg. in the pulverized-coal discharge pipe. Automatic control is provided so that the heater is shut off when the air reaches a desired maximum temperature that can be regulated to suit conditions. The dry pulverized coal is discharged into a 60-t. storage hopper, ready for distribution.

*General Manager, Ewart Plant, Link-Belt Co., Indianapolis.

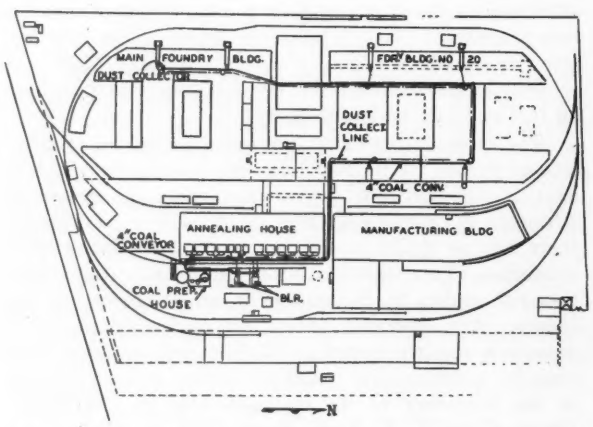


FIG. 1. PLAN OF COAL PREPARATION AND DISTRIBUTION SYSTEM

Automatic Distribution Control

Distribution by means of a pneumatic conveying system is controlled from a central signal board at the main storage hopper. The coal is conveyed through 4-in. standard steel pipe, direct to the various units to be fired, first being fed into a 5-t. tank mounted on a scale with weightograph attachment which accurately records the amount of fuel used.

Parallel to the conveying line is a dust collecting line, which removes the fine coal dust carried off by the cyclones located at the furnaces.

To illustrate the automatic operation of this system, assume that coal is needed for furnace No. 1; the furnace attendant pushes an electric button and a colored light appears on the central sign board, showing that coal is desired at No. 1 furnace. The operator then presses a button which releases the switching valve at No. 1 furnace and allows the furnace attendant to open the valve by pulling a pendant chain. Automatically, a different colored light flashes on the central control board,

informing the operator that the valve at No. 1 is open, ready to take coal from the main feed line. The coal is conveyed by compressed air at 15 to 35 lb. pressure and, as soon as it reaches a predetermined level in the storage bin at the furnace, an automatic limiting device closes the inlet valve and stops the coal flow. At the same time a third light flashes on at the central control board to tell the operator that No. 1 furnace has been supplied.

The system is so inter-locked that no switching valve for drawing coal from the main line can be opened by its pendant chain until the operator at the central control board has released the valve. The safety manhole cover on each individual storage hopper is also interlocked so that no coal can be conveyed into the hopper unless the manhole cover is properly sealed. The cost of transporting coal by compressed air averages 6 c. a ton.

From the furnace hopper a screw feeder attached to the bottom feeds the coal at the desired rate, positively controlled by a Link-Belt P.I.V. Variable Speed Transmission, for combustion.

Burners Adapted to Work

Three different styles of burners are used. All melting furnaces are equipped with stream line burners, which give a low velocity flame required for metallurgical melting. Annealing ovens are equipped with high-low velocity burners which give a flame of variable length, a short flame for starting and a long flame for bringing up the iron in the oven and holding an even temperature. Each of the three 20-t. ovens has one burner; the ten 35-t. ovens are equipped with two burners each. Three 200-hp. h.r.t. boilers used for heating the entire plant are equipped with the turbulent type of burner, which gives a short, hot turbulent flame suitable for this class of work.

Aside from the convenience of automatic, perfectly-controlled operation, on the annealing ovens, several hours have been cut off the cycle of operation, because the temperature throughout the entire oven is uniform, castings can be placed in any part, regardless of size, and come out thoroughly annealed. With hand firing, these ovens required 752 lb. of fuel per ton of castings annealed; with pulverized coal, the consumption has been brought down to an average of 500 lb. of fuel per ton.

In the melting furnaces, a higher percentage of good castings and more uniform analysis of iron are obtained with very hot fluid iron, 2700 deg. F. and above, at the spout, which retains its temperature in the ladle longer than with hand firing. On the boilers, which are operated only for heating the plant, there is the double saving of labor and fuel, with the advantage of a more easily controlled heating plant.

Data on the cooling system of the 3000-seat Fox Theatre in San Diego was recently given by P. P. Pine in Byllesby Management. This is a 150-t. spray system set for 50 per cent relative humidity. The air conditioning part will be used throughout the year, as it is necessary to heat and humidify the air in winter. The complete cost of installing the equipment was approximately $30,000. The maximum demand is 184 hp. and the connected load totaling 188½ hp. is as follows: Compressor (variable speed motor), 150 hp.; circulating pump, 20 hp.; condensate pump, 15 hp.; vacuum pump, 1 hp.; refrigerant pump, 2½ hp.

Freight Elevator Operation and Maintenance

By H. L. Schultz*

Most elevator mishaps which often result in personal injuries, either serious or fatal, can be prevented by using the same rigid inspection and maintenance that have proved valuable on production equipment, rather than by meeting the requirements of state industrial codes at periodic inspections and letting the responsibility of keeping the elevators in safe operating condition take care of itself. Investment in insuring safe operation is better than expenditure for compensation paid out after an accident.

To cite a few instances: Investigation as to the cause of a serious foot injury, which resulted when a platform shifted as it was being placed in position on an elevator, spilling its contents of heavy bags, revealed badly worn guide rail shoes and uneven wear in the grooves of the cable drum. This caused not only a slack cable on one side but also a twisting play in the elevator floor, allowing the cage to list.

Besides keeping the equipment in safe condition, operators must be instructed in safe practice. One quite well established rule, seemingly seldom enforced, is that no trucker should back his truck, whether of the hand lift or electric type, into an elevator. On one occasion a trucker, arranging platforms around the elevator entrance on the third floor of a building, the elevator being at fourth floor, was endeavoring to set a loaded platform directly in front of the entrance. The brake on the electric truck failed to hold, allowing the truck and loaded platform to plunge through the slatted service gate and down the shaft. The trucker jumped, thus saving himself.

Many accidents are due to the old type traction machine which lets the elevator cage list or move several inches, before coming to a stop when placing a load. In the drum type machine, this condition can generally be traced to one of four things, worn shoes or guide rails, uneven wear of cable grooves in drum, stretched cables, or faulty electric brake. In the traction type machine the trouble will be found, nine times out of ten, as either slack belting or a brake that is too tight to shift readily.

Old type cable-grip starting elevators on which there are no regular operators should always be equipped with automatic safety hand cable grips, which will prevent starting the machine from another floor by another workman. Several of these devices on the market are inexpensive and many a serious mishap has been prevented by their use. For the electrically controlled elevator with its automatic gates and interlocks, this danger is not present. Faulty wiring will, however, do funny stunts and it is no uncommon occurrence to have a short circuit in the starting circuits and interlocks show up when the elevator is severely jarred as when loading or unloading, starting the cage on its travel without notice.

The foregoing examples emphasize the importance of a definite program of inspection, maintenance and accident investigation. General operating conditions should be checked daily and any adjustments and repairs made immediately. Where the number of elevators

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*Asst. Supt. of Maintenance, The Carborundum Co., Niagara Falls, N. Y.

justify it, adjustments and repairs should be made by men trained in this work. Local requirements will determine whether a card follow-up system should be set up under the direction of an engineer well versed in the requirements. Every accident should be thoroughly investigated by a safety committee assigned for the purpose and a report submitted as to its findings to prevent a similar occurrence in the future. Such reports should also be filed and periodically reviewed.

Good lubrication is a big help towards lower maintenance and hazard elimination. This should be watched in arranging the inspection schedule. Guide rail lubricators, automatic in operation, cut down upkeep of both rails and shoes. Incidentally it may be well to look into the possibility of babbitting shoes instead of replacing them with new ones when they have become worn. Most shoes are heavy enough to allow shaping out to receive a liner or wear strips of babbit. For several elevators of like design, one spare set of shoes will suffice, almost for all time. Often these parts may be babbitted in place in a minimum of time.

Inspections should be thorough, especially as to inner workings and general lubrication. This should include gates and interlocks, also spacing of slats on service gates and working order of fire doors. Magnetic switches, brakes and hand cable grips, emergency relief devices should be periodically inspected and frequently adjusted. When testing, cars should be loaded to maximum capacity, then run up and down the hoistway several times to check upper and lower automatic limit devices. Cars should also be stopped at various levels to test the operation of machine brakes. Elevators having speed governors should be started at the top and run beyond normal speed, to operate automatically speed governors, car safeties and slack rope devices. The slightest discrepancy in proper operation of these devices should be immediately investigated and remedied.

This suggested schedule is for cars whose normal speed is in excess of 100 ft. per min. Where speed is less than this, governors may generally be manually tested. Where there are no speed governors, safety devices may be effectively tested by slacking the hoisting cables. In addition to the auxiliary electrical parts mentioned, all wiring and conduit should be inspected, with special attention to any phase-reverse relay circuits, as it is here that short circuits can so easily be overlooked until an accident has occurred. In the traction type of elevator, the same care must of course, be exercised in going over all transmission equipment and mechanically operated parts.

Inspection of sleepers and other supporting members for the car floor should ensure that maximum loads may be safely carried. Of equal importance are the cables which should be carefully checked for the number of broken strands and then compared with the safe load recommended for cables under such conditions or required by the industrial code.

A freight elevator may well be compared with the proverbial chain and its weak link. It is false economy to treat its safety and maintenance indifferently.

SHAFT SELECTION should consider load due to belt pull and weight of pulley and clutches, as well as power to be transmitted.

Vertical Belt Drives

BY W. F. SCHAPHORST

IN A LATE number of Power Plant Engineering it is correctly stated that wider belts must be used on vertical drives than on horizontal drives. I would like to add something to that. An important question relative to vertical drives which has never been answered, so far as I know, is the following: "What is the smallest angle from the vertical that will overcome the sagging of the belt away from the bottom pulley, assuming that a wrapper pulley is not used?"

Usually a first class high friction belt will take hold without need of a wrapper pulley in 5 to 10 deg. from

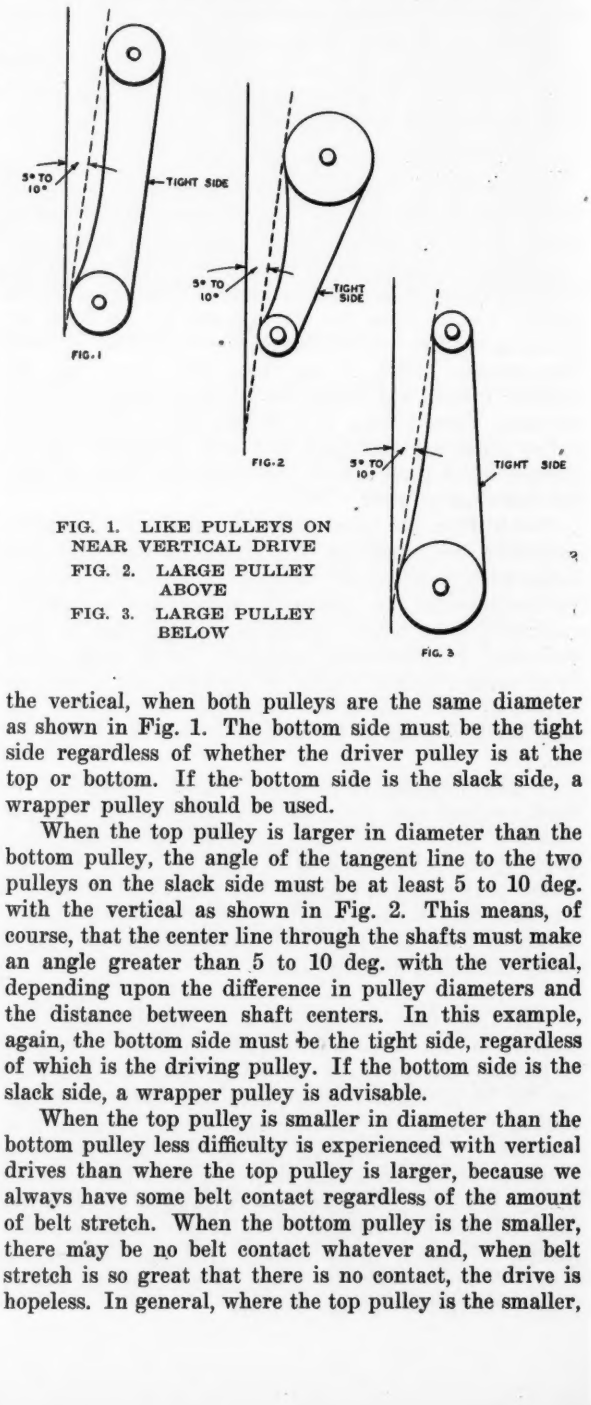


FIG. 1. LIKE PULLEYS ON NEAR VERTICAL DRIVE
FIG. 2. LARGE PULLEY ABOVE
FIG. 3. LARGE PULLEY BELOW

the vertical, when both pulleys are the same diameter as shown in Fig. 1. The bottom side must be the tight side regardless of whether the driver pulley is at the top or bottom. If the bottom side is the slack side, a wrapper pulley should be used.

When the top pulley is larger in diameter than the bottom pulley, the angle of the tangent line to the two pulleys on the slack side must be at least 5 to 10 deg. with the vertical as shown in Fig. 2. This means, of course, that the center line through the shafts must make an angle greater than 5 to 10 deg. with the vertical, depending upon the difference in pulley diameters and the distance between shaft centers. In this example, again, the bottom side must be the tight side, regardless of which is the driving pulley. If the bottom side is the slack side, a wrapper pulley is advisable.

When the top pulley is smaller in diameter than the bottom pulley less difficulty is experienced with vertical drives than where the top pulley is larger, because we always have some belt contact regardless of the amount of belt stretch. When the bottom pulley is the smaller, there may be no belt contact whatever and, when belt stretch is so great that there is no contact, the drive is hopeless. In general, where the top pulley is the smaller,

a good general rule is: The angle of the tangent line to the two pulleys on the slack side should be at least 5 to 10 deg. with the vertical as shown in Fig. 3.

It is evident that under certain conditions of pulley diameter difference and center distance the center line through the shafts can be truly vertical and yet give us an angle sufficient to cause wrap and grip with a first-class high-friction belt. Either pulley can then be the driving pulley and either side can be the tight side. No wrapper pulley will be needed.

It is assumed in the above that the drive is non-fluctuating. If the drive fluctuates, the angles with the vertical must be greater than 10 deg.; the more violent the fluctuations, the greater must be the angle. Or wrapper pulleys must be used. In fact we sometimes have fluctuations so violent that wrapper pulleys must be used even on horizontal drives.

Important points to bear in mind in connection with vertical drives are: 1. Use the best quality, most pliable, highest friction belt you can get. 2. Use two-ply belting rather than single because double belting is less likely to stretch. 3. Use belts of ample width. 4. Use pulleys of ample diameter. 5. Operate the belt at sufficient velocity so that it will wrap itself around the lower pulley. A high velocity belt on a vertical drive is almost invariably more satisfactory than one of low velocity as the latter must be kept tighter or a wrapper pulley must be used on its slack side.

Wire Rope Stress Elimination

By Edward J. Kunze

STRENGTH of rope depends not alone on the material used in the wire; the condition of that material in the finished rope also has considerable influence on its strength, hence the process of manufacture, in so far as it modifies the condition of material, is an important factor. Another factor in life of the rope is the manner in which the rope is used. Reverse bending over sheaves should be avoided not primarily because of wear but because additional internal stress is set up in the wires.

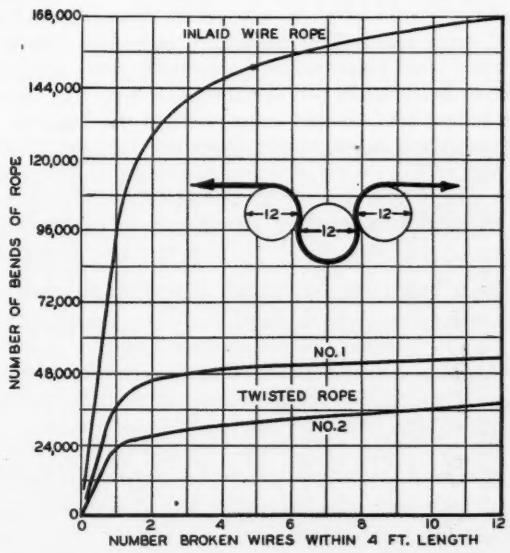
While the breaking load to pull a rope apart is an indication of strength, several forces act while a wire rope is in use other than that which produces tensile stress and these have a greater influence in reducing the life of the rope than direct pull. All of us have broken a wire by bending it back and forth and have observed that the more rapidly we produce these alterations the hotter the wire becomes until, finally, breakdown of the structure at the point of maximum bending takes place. This bending back and forth occurs every time a rope passes over a sheave or drum and the greater repeated bend, as when small sheaves are employed, especially the introduction of reverse bends, greatly reduces the life of the rope.

Internal Stresses

Outstanding developments in wire rope construction have been introduced, first by preforming the wires and strands to the helical shape assumed by them in the finished rope so that they lie together in a state of relaxation; second, in annealing and subsequent heat treatment of the finished twisted type of rope to eliminate internal stress.

Twisted wire rope has internal stress from torsional distortion set up in the winding process usually employed in making the rope. This internal stress is inherent in this process of manufacture and, unless the rope is heat treated shortens its life because this stress acts simultaneously with that due to the load.

To realize how forcibly the wires and strands are held in their helical shapes in twisted wire rope, it is only necessary to cut such a rope with a hack saw or wire rope cutter. The moment a wire is severed, it is like removing restraint from a spring. The wires and strands fly out as they are cut, resembling a wire brush, hence it is customary before cutting wire rope, to bind it, near the place where the cut is to be made, in order to avoid danger.



BREAKAGE OF WIRES FROM FATIGUE TESTING BY REVERSE BENDING

Three distinct stresses act simultaneously in each wire when twisted rope is used to transmit power by running over sheaves or drums: A tensile stress due to the load applied; a torsional stress, which is the result of winding the wires into position in the strands and strands into rope; a bending stress, due to passing the rope around the sheaves and drums. Stresses should be uniformly distributed in the rope so that each wire will bear its proportional share of the total load but, with twisted wire rope, the torsional stress set up in making the rope may vary considerably.

Torsional Stress May Be Reduced

Preforming the wires and strands so that without resort to force they will assume their proper positions in the strands and rope respectively avoids setting up internal stress, hence there will be no tendency for such preformed wires to fly out at the ends when cut. Each wire and strand fits into the rope without restraint, hence may be picked out and returned to its place without use of force.

Laboratory fatigue tests substantiate the conclusions arrived at in the above discussion. These tests were made in a machine which moved the rope back and forth over 12-in. pulleys placed as shown in the figure so that for each cycle (a cycle consisting of a forward and re-

turn movement) there were six bends or three reversals. The curves show average results of a number of tests. In each test all ropes were of the same size and material and of the same construction except for the preforming of the wires and strands in the one case. All ropes were tested under the same speed and under a load of 2000 lb. The machine was stopped at given intervals, rope closely inspected and the number of broken wires in each 4-ft. length, tabulated.

By inspection of the curves plotted from tests on ropes made of plow steel, it will be seen that while only one wire of the preformed rope broke after 96,000 bends, 12 wires of one twisted rope had broken after 53,000 bends and the same number had broken after only 38,000 bends in the other.

Forming the wires and strands before assembling them in the rope requires a separate operation and the use of extra and special machinery and tools. Depending upon their positions in the strands, wires are given different bends when preformation is resorted to. Moreover, unless heat treated subsequent to the bending, an internal stress, much lower, however, than that due to twisting will be set up, due to this bending. Assembling wires which have been bent for inlaying is also more complicated than winding straight from a coil into a strand.

Heat Treatment Removes Internal Stresses

Passing wire rope through a gas or electric furnace for a predetermined length of time and at a predetermined temperature will lessen internal stresses in the wire. If greater strength of rope is desired, the heat treatment may be continued; that is, instead of allowing the rope to cool and anneal, it may be heated further and quenched, following standard practice for the particular material and service required. Such heat treatment is easily performed with standard equipment and this process may follow, in sequence, the making of the rope, without extra handling, in a furnace and bath installed alongside of the rope-making machine. In manufacture of rope in the usual manner by twisting the wires into strands and the strands into rope, supplementary heat treatment produces a superior rope at a nominal increase in cost.

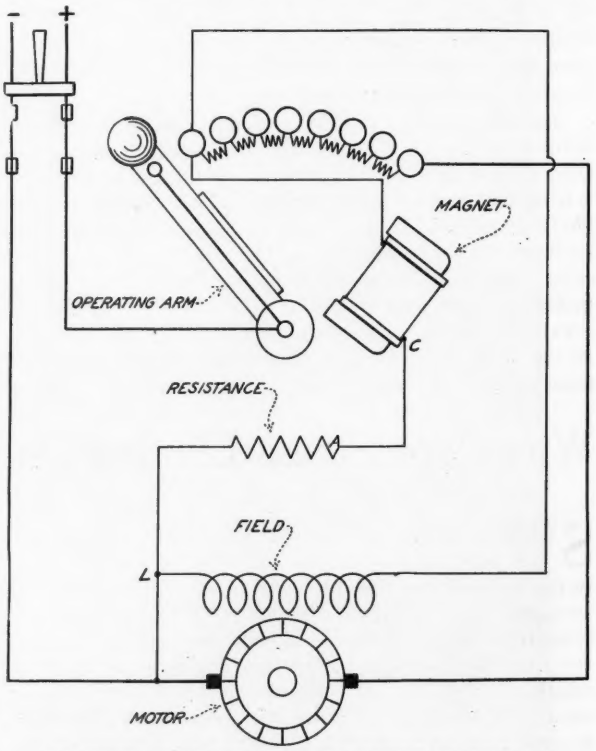
Breaking of wire rope entails expense, not only for replacement but also from loss of availability of the machine on which it operates and of idle labor time which is involved. These losses may be greater than cost of replacement, hence reduction of such losses by use of rope in which internal stresses have been eliminated is highly desirable.

Standing committees of the American Society for Testing Materials will hold their annual Spring Group Committee Meetings in Cleveland, beginning Monday, March 7 and extending through Friday, March 11. In conjunction with these is the third Regional Meeting sponsored by the Society, which will be held on Wednesday, March 9. Sessions and dinner which make up the meeting will be in the Hotel Cleveland. A Symposium on Rubber is to be held in the morning and afternoon sessions in which outstanding authorities in this field will present papers. The meeting is being arranged by the Cleveland District Committee of the Society and the technical program is being sponsored by Committee D-11 on Rubber Products.

Starter Release Magnet Fails

Upon starting a direct-current motor driving a pipe-threading machine, the no-voltage release magnet failed to hold the operating arm of the starting rheostat in the running position, so the operator lashed the arm to the magnet coil with a piece of cord. Subsequently, the source of current supply was accidently cut off and, when it was restored a minute or two later, the rush of current under full voltage proved disastrous to the motor.

Failure of a rheostat magnet to hold may be the result of poor contact between the magnet and the keeper attached to the operating arm but generally it is due to a break in the electrical circuit. In this instance, search for the break had been limited to a test of the magnet coil. As this was found intact, it was concluded that the magnet simply was too weak. Following the damage to the motor, a more thorough search located the defect in the protecting resistance in series with the coil at point A.



STARTER CONNECTIONS DEFECTIVE AT POINT A

This protecting resistance is mounted on the back of the starting panel and usually is connected across the main circuit in parallel with the shunt field, as shown in the accompanying sketch. On some installations, however, it will be found connected in series with the shunt field. It may be tested for breaks by connecting a magneto between the terminals marked C and L in the sketch.

D. J. Altizer.

The expression "evaporation from and at 212 deg. F." has been fixed by the Boiler Code as 970.4 B.t.u. per lb.

CORROSION PREVENTION In Ice Plants

The author who has been the pioneering leader in the control and prevention of ice and refrigeration corrosion tells how properly treated brines have shown 95 per cent protection. Treatment is easy to introduce, does not interfere with plant operation and if done properly does not affect the skin of operators.

GUY V. THOMPSON
Corrosion Engineer
New York

INTEREST in corrosion prevention has been steadily growing and plant owners are beginning to realize the tremendous savings and benefits that result from properly treated brines. I have received inquiries from all parts of the country asking what to do to obtain good results and while I have answered them the best way I can, nevertheless I realize that this method is unsatisfactory because, in order to obtain best results, there are many points too numerous to mention that must be carefully weighed before a treatment is advised and introduced.

Practice has definitely shown that corrosion problems can not be cured by rule of thumb methods. No corrosion retarder however good will be of much value unless someone who has had practical experience in this work makes a survey of existing local conditions before attempting to treat the brine. The mere purchase of a good corrosion retarder and shipment of it to a plant to be used as a treatment is not sufficient. It is not a "cure all" unless scientifically applied and good judgment must be used in handling the matter. This is especially true of plants that are already in operation and corrosion in various forms has begun its work.

New Calcium Chloride Brine Highly Alkaline

Experience has shown that treated calcium chloride brine is less corrosive than sodium chloride brine, due principally to the fact that a greater density is usually carried and consequently less oxygen is absorbed. On the other hand, new calcium brine that is untreated is more corrosive than sodium brine because it has an initial high alkalinity, having a pH value of approximately 12.5, so the galvanizing is removed from the cans in a short time.

This high alkalinity of calcium chloride is an advantage when new brine is treated with a corrosion retarder having an acid base because when the retarder is introduced in the proper proportion, the resultant pH value is usually sufficiently high without the addition of any other alkali.

Of course, old calcium and sodium brines may be quite acid and require the addition of an alkali. If caustic soda is added, it must be done carefully both as to the method of introduction and amount added. It is not advisable to add caustic by formula because, in case of an overdose, a heavy precipitation occurs and if the cans are stationary, such as in the Arctic-Pownall system, it becomes practically impossible to thaw off the ice until this condition is corrected.

TANK ROOM OF THE FRANKLIN ST., BALTIMORE DEPARTMENT OF THE AMERICAN ICE CO. WHERE THE BRINE WAS TREATED 5 YR. AGO AND THE CANS STILL LOOK LIKE NEW

While it is possible to get a close approximation of the total amount of acid required if it should be necessary to reduce the alkalinity by the addition of acid, nevertheless considerable care must be exercised and a number of tests for pH value made during its addition to check the amount estimated.

Each Tank a Small Electric Battery

Each tank is really a potential battery when there is a steel grid resting on the sides of the tank thus acting as a bus bar and the cans suspended from this into a salt solution acting as zinc plates. It is possible to get a reading on a millivoltmeter on almost any tank of this type between can and brine or tank and brine. In most cases, however, these small currents can be disregarded and cases of severe electrolysis are very rare unless d.c. current comes into contact with the system from an outside source.

In one plant that I treated, the galvanizing was removed from the cans in two of the tanks and when, upon checking the effectiveness of the treatment by means of samples suspended in the brine, it was found to be giving the proper protection, tests were made for electrolysis which showed 20 to 100 milli-volts between tank and brine.

Later experience, however, has convinced me that the removal of galvanizing from the cans in these two tanks was due to the fact that the old brine was not thrown away when the new cans were installed. This brine had had a great deal of ammonia leak into it in the previous years and was in a very corrosive condition. The following year, there were several very bad ammonia leaks in these tanks. To neutralize the first leak in one tank, I calculated it would take a little over 600 gal. of acid. Of course, this amount was not added as it is never advisable to put anything like this amount of acid in a tank.

These cans have been in this brine for over three years and while a great deal of ammonia was gotten rid of later on, nevertheless they have had an extremely severe test which has been of great value in demonstrating the effectiveness of the treatment. The cans in these tanks today, while they have no galvanizing, are perfectly clean and free from rust and in excellent condition. Without treatment under these severe conditions, it would undoubtedly have been necessary to replace the majority of these cans if not all of them. The treatment has kept them in good condition and I believe they will never be replaced due to corrosion.

Prevention Always Worth While

If the brine in these tanks had not been treated and the majority of the cans renewed in about four years, the new cans would undoubtedly have been replaced in the same corrosive mixture that had eaten up the first ones. If the plant owner had not contemplated treatment or considered it advisable when the first new cans were installed, it is not likely that he would have considered throwing away the brine. Replacements would have been put in the same brine which would become more corrosive as the rust particles in it increased. The time between renewals would become shorter.

Under these very severe conditions even if the cans only lasted twelve years with treatment (and I feel sure they will last much longer) cans without treatment would have had to be renewed three times during that period. As there is a total of 1604 cans in these two tanks at an average price of $5.50 per can, the cost of one renewal would be $8,822.00 or $26,466.00 for three renewals. Of course all of the cans would not have to be renewed each time but even if only 60 per cent of them were replaced the cost would be $15,879.60.

This sort of thing goes on under more or less severe conditions in all untreated tanks and the immense saving that proper brine treatment gives is clearly demonstrated. I find a number of plant owners who do not wish to treat the brine in certain tanks because they feel that the cans in these tanks have only a few years before it will be necessary to replace them. On the other hand, I find some who feel that because their brine and equipment is new or in good condition, it is not yet necessary to treat the brine. The reasoning is wrong in both cases.

Treatment tends to keep the material in the condition it is at the time of treatment. In other words, the new tanks, cans, coils or brine coolers remain in the new condition as far as corrosion is concerned. If the material is old and rusty, the treatment removes the rust and protects it against further corrosion. Only in rare cases where this material is so old and heavy with rust that there would be practically no metal left if it were removed, is the treatment inadvisable.

Treatment a Protection During Reconstruction

Cans that have been for some time in properly treated brine can be removed from the tank for a long period without rusting. This is also a great asset because when reconstruction is going on and changes are being made the cans must be removed from the brine and every ice man knows the rust that accumulates on them in a short period when exposed to the air unless they have received the protection of proper brine treatment.

During reconstruction there is also a great deal of labor spent in endeavoring to remove rust from cans, coils and tanks which would be entirely unnecessary if treatment had been applied. The pay rolls of crews removing such rust are large and the finished job is a poor one. All the rust can never be removed and often the harsh methods of removal by means of hammers and wire brushes cause leaks. Many a pin hole has been opened up in a pipe by a hammer. The job at best is expensive with unsatisfactory results.

Some are under the impression that it is necessary to throw away the old brine and mix new before a treatment can be introduced. This is not true in the majority of cases and I have experienced a number of instances where proper treatment has changed a brine from a red, rusty, corrosive mixture to a clear, clean, non-corrosive one. If new cans are to be installed, however and the brine shows considerable ammonia present, the galvanizing would last longer if the brine were discarded.

There also seems to be a general impression that if the brine is clear it is non-corrosive. This is no more true than in the case of water which may be perfectly clear but full of typhoid germs. Of course it is an asset to have it clear but the really important thing is to have it non-corrosive. Salt brines usually clear up with proper treatment so it is possible to see the rivets on the bottom of the tank. On the other hand, calcium brines rarely clear up unless specially treated for that purpose.

Treatment Takes But a Short Time

Treatment can be introduced in a short time unless there are some unusual conditions to be overcome. This can be done while the plant is running without causing any delay or interfering in any way with its operation. There is nothing required of the plant owner except the services of a man for an hour or two to introduce the treatment. If the treatment is put in in the proper proportion, it should last at least a year before it is necessary to add any to it. This holds true for any type of plant whether the cans are stationary or removable. First cost of the treatment is low as compared to almost any other maintenance item especially when the value of the material protected is considered.

Infection

Many ask whether the tankmen will have a skin infection if bichromate of soda is used. If the treatment is introduced in the proper proportion, it is not dangerous to plant operators. Even when the cans are pushed by hand and the operator is in almost constant contact with the retarder, there is no danger if ordinary cleanliness is observed. If any operator has any cuts or abrasions, he should keep them tied up and clean in order to keep out any impurity whether it be a corrosion retarder or other foreign substance.

In summing up, I will say that practical methods of corrosion prevention have proven a great saving to plant owners. Properly treated brines have given above 95 per cent protection against corrosion to the most expensive part of an ice plant. The treatment is easy to introduce and does not inconvenience the plant operation in any way and when properly applied does not affect the skin of the operators. The initial as well as the follow-up cost is extremely low compared to the value of the material protected. To attain proper results the problem of corrosion prevention should be handled by someone who has had practical experience in this work.

Interconnection to Improve Load Factor

Interconnections Between Utility Systems and Private Plants of Value to Both Parties Involved

AMONG VARIOUS new factors which enter into the economies of modern power plant operation, one which is of considerable importance is that of interconnections with electric public utility systems. Interconnections between the utilities and industrial plants under proper conditions can be of mutual benefit to the parties interested. To the utility company, interconnection is of value as a source of revenue; to the industrial power plant, it assures continuity of service under all conditions, and to both the industrial plant and the utility, interconnection brings the possibility of improved load factor.

Load factor is an extremely important item in the operation of any plant for it vitally concerns the monetary return on the capital invested in the plant. The most efficient plant in the world will be unable to show profit under conditions of poor load factor; hence any means at our disposal of improving the existing load factor in a plant should result in increased earnings.

Recognizing the importance of high load factor, wise far-seeing utility executives and private power plant operators in a number of instances have established interconnection between their respective systems so that the private plant may draw upon the public service system when it requires power in excess of its nominal demands and generating capacity and at other times when its demands are below normal, it may supply power to the utility system. Thus, provided the peaks of the two systems are not coincident, both systems profit by such an arrangement by improved load factor.

In instances of this kind, it must not be assumed, necessarily, that the private plant can charge for power furnished the utility at the same rate that the utility charges for power to the private plant. The power rates must be based on the relative value of the purchased power to the system buying it. It must be quite evident that the relatively small amount of power which the private plant is able to furnish the utility is of much less consequence in smoothing out the load curve of the utility system than is the comparatively large amount supplied by the utility to the private plant.

Various arrangements and agreements are possible. In one case, that of a small cement plant in eastern Pennsylvania, there is no direct charge for power, either way. The plant operates continuously for about 11 months out of the year. During the twelfth month, the plant is completely overhauled and the power plant shut down. So an agreement has been established whereby the power plant for the cement plant furnishes all its excess electric power to the utility lines for eleven months of the year; then, during the twelfth month, when the cement mill plant is shut down for overhauling, all the power required by the cement mill is supplied by the utility system.

In a plant burning fuel directly and primarily for electric power making purposes, such an arrangement would not be equitable since an additional amount of coal is necessary to generate the excess electric power. In this instance however, all the steam used by the turbines is generated in waste heat boilers and since this heat would be wasted anyway it may just as well be used to generate power.

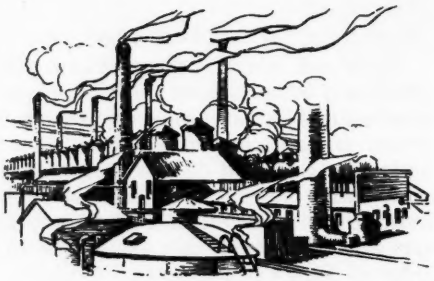
There are many possibilities in interconnections of this type and representatives of both the utility industry and the private plants are exhibiting a growing interest in this phase of power plant operation. In order to make interconnections of mutual benefit to the interested parties, the load demands must be so regulated as to minimize power charges and capital investment. Aside from whatever mutual benefits are to be derived by the interested parties by such interconnections, it has additional value in that it tends toward a conservation of natural resources.

Trend away from municipal ownership of electric light and power plants is apparent in Iowa, according to Joe Carmichael, director of the Iowa committee on public utility information, who addressed the sales and distribution school held in Sioux City, Iowa, recently in connection with the annual convention of the Iowa division of the National Electric Light Association. The meeting was attended by 150 members.

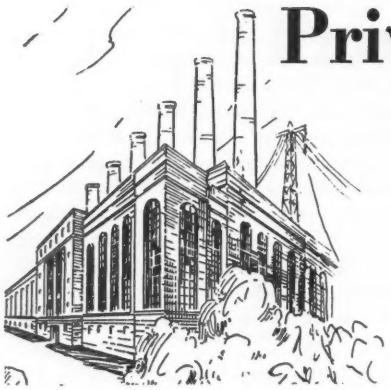
Mark Hapster, Mason City, was elected chairman of the organization at the concluding business meeting. He succeeds V. O. Stafford, Sioux City.

W. H. Rademacher, Edison Lamp Works, Chicago, discussing future growth of electrical service, which he said must come by increased sales to existing customers, pointed out that less than a third of established businesses use electrical advertising and asserted that market for flood lighting and decorative lighting is but in its initial stage, while dual purpose lighting and sun lamps in the home loom as great new fields. Paul C. Porter, Iowa Southern Utilities Co., reported that the agricultural depression did not deter Iowa farmers from availing themselves of advantages of rural electric service last year and, describing methods of establishing such service, detailed systems averaging from $54 to $100 a year.

POWER PLANT ENGINEERING February 15 1932



Cooperation Between Private Plants *and* the Utilities



By OTTOMAR H. HENSCHEL
Consulting Engineer
Milwaukee, Wisconsin

WITHIN CONTROL of the average industrial executive lies the ability to secure for himself minimum power and steam costs. They are his just as he may will. As a rule, however, he does not take full advantage of the opportunities before him. Perhaps this is due to his unfamiliarity with the technicalities of the subject although even these should not stand in his way for, readily enough, they may be simplified to a degree comprehensible to the average school boy.

That electric energy may be purchased at times at a cost lower than that at which it may be locally generated is not open to argument. It is also true, however, that if factors involved are given due and unbiased consideration many industries would be enabled to realize savings by the installation of their own power plants, particularly when and where the industry requires a considerable quantity of low-pressure steam for process or space heating.

Of course, and perhaps unfortunately, all industries cannot be classified as simply as this. Some industries may at times, during the summer months for instance, find it more economical to purchase their requirements while as soon as steam is required for heating a loss at once is encountered. This, however, need no longer be the case. Where some utilities in the past have attempted to force sales by requiring consumers to take all or none of their electric energy requirements, some few of these public service companies are today awakening to the realization that coöperation is better business than strangulation.

Accordingly, in some localities, it is becoming possible for consumers to install and operate their own generating plants as and to an extent consistent with the industry's demand for low-pressure steam. In other words, when no exhaust steam is required for heating or process, practically all of the electric energy required is taken from the utility. But as a process or heating steam demand is created, a generating unit may be pressed into service with an amount of electric energy extracted as will provide the necessary amount of low pressure steam. The amount of electric energy capable of being generated will naturally vary although in some instances, as will be indicated, full generation may be possible during some few months of each year with resulting costs lower than otherwise possible.

Obviously, such a partial generation scheme ultimately results in mutual profit to both utility and consumer, the latter securing his electric energy requirements at a minimum of cost.

This arrangement, while not new in the case of some of the larger industrials, has of late been extensively adopted by some of the smaller manufactories. The results have been satisfactory and the financial returns have been gratifying.

To indicate just what is possible, several case studies will be presented in which the partial generation scheme is in use, or ready to be adopted. We will consider first a wood-working toy plant, and second, furniture manufacturing establishment.

In the case of the wooden toy factory absence of operating records covering past performances required the making of several assumptions. Where this was done, however, an attempt was made to be as conservative as possible:

Originally three major problems required consideration. These were as follows:

(A) Does it appear most profitable to remodel the existing power plant so as to allow generation of all electric energy requirements, part or all of the time?

(B) Would purchase of all electric energy requirements prove the most economical?

(C) Would it be the most financially advantageous to generate only such an amount of electric energy as would at all times conform to heating and process steam requirements and no more? Anything in excess of such an amount of generation to be purchased.

Information provided revealed an almost constant load of 332 steam-engine indicated horsepower. Accordingly, with a load factor of 24 per cent (applicable to

wood-working plants of this nature) the preliminary data appeared as

Indicated horsepower 332
Actual horsepower
(332 times 0.85 times 0.95).....268
Equivalent kilowatts 200
Probable monthly electric energy consumption (200 times 720 times 0.24)..34.560
Approximately .....34,000 kw-hr.
With a demand of..... 200 kw.

Two hot blast type units are installed for space heating. One has a rating of approximately 5,000 sq. ft. while the other has a capacity of about 1,800 sq. ft., or a total equivalent of 19,120 lineal feet of 1-in. pipe. This, under local climatic and other conditions, was found to provide approximately 11,472 lb. of condensation per hour; however, consideration was required given to the demands of the hot blast from engines which were equal to about 3,300 lb. of steam per hr. so that, as a consequence, there appeared available.

Steam required for space heating.....11,472 lb. per hr.
Fan engine requirements ..... 3,300 " " "

Net exhaust steam to be supplied by a generating unit ..... 8,172 lb. per hr.

To be conservative, however, it was assumed that on an average during a seven months' heating season the hot blast units were operating but 75 per cent of their capacity, thus indicating an apparent net amount of steam available for generation equal to 8172 times 0.75 or, 6129 lb. per hr. In fact, with minimum process requirements during heating months 6500 lb. of steam per hr. was accepted.

As a result, with various water rates of generating units the following kilowatt generation capacities were available.

Water Rate of Generating Unit —Lb. Per Kw-hr.	Generation Capacity Available Kw.
30	217
35	185
40	162
45	144
50	130
55	118
60	108
65	100
70	90

Costs With All Energy Purchased

For the sake of simplicity, only actual working hours during which steam and electric energy are required were taken into consideration for the purpose under consideration. Obviously, for all other times heating requirements and costs would remain unchanged and accordingly could well be neglected.

As a consequence, then, on the basis of a 9-hr. working day and a 26-working day month the accepted steam requirements appeared to be

Heating and process steam requirements during heating months.... 6,500 lb. per hr.
Heating and process steam requirements during semi-heating months (April and September)..... 3,500 lb. per hr.
Process steam requirements during non-heating months ..... 1,000 lb. per hr.
Or, on a monthly basis
Heating and process steam requirements during heating months....1,521,000 lb. per mo.
Heating and process steam requirements during semi-heating months 819,000 lb. per mo.
Process steam requirements during non-heating months ..... 234,000 lb. per mo.

Accordingly, then, the monthly working hour coal cost, under an apparent existing evaporation of 7 lb. of water per pound of coal burned and a coal cost of $6.00 per ton was found to be

Month	Apparent Average Probable Cost
January	$648.00
February	648.00
March	648.00
April	354.00
May (6 lb. evaporation)	112.00
June	112.00
July	112.00
August	112.00
September	354.00
October	648.00
November	648.00
December	648.00
Total	$5044.00

The purchased electric energy costs were based upon an average monthly consumption of 34,000 kw-hr., this as already discussed. In consequence of this the billing for such consumption and, with a demand of 200 kw., would appear to be

200 × 10 × $0.10	$200.00
3,000 kw-hr. @ $0.03 per kw-hr.	90.00
5,000 " " @ 0.02 " " "	100.00
5,000 " " @ 0.015 " " "	75.00
19,000 " " @ 0.010 " " "	190.00
Gross	$655.00
Discount—5 per cent	32.75
Net	$622.25

Thus, with all electric energy purchased the annual operating expense for fuel and that energy would appear to have resolved itself as

Month	Apparent Average Fuel Cost	Apparent Average Purchased Energy Cost	Apparent Average Total Cost
January	$648.00	$622.25	$1270.35
February	648.00	622.25	1270.35
March	648.00	622.25	1270.35
April	354.00	622.25	976.25
May	112.00	622.25	734.24
June	112.00	622.25	734.24
July	112.00	622.25	734.24
August	112.00	622.25	734.24
September	354.00	622.25	976.25
October	648.00	622.25	1270.35
November	648.00	622.25	1270.35
December	648.00	622.25	1270.35
Total	$5044.00	$7467.00	$12,511.56

Under conditions of all electric energy requirements being purchased, no investment in equipment was to be-

come necessary so that, as a consequence, the unit cost for this energy would appear to have been $0.0306 per kw-hr.

Cost of Full Generation

Opportunity had presented itself for the purchase of a used 400-kw. engine-driven generating set and consideration given the subject of full energy generation. The problem under these conditions was then analyzed with the following results. Estimated initial and annual operating charges appeared as

Cost of unit installed foundation	$9024.00
Foundation	1000.00
Switchboard	700.00
Piping, wiring, etc.	1500.00
Total	$12,224.00
Interest on investment at 6 per cent	733.44
Depreciation—10 per cent	$1222.40
Taxes and insurance—at 2½ per cent	305.60
Maintenance—10 per cent	1222.40
Total	$3483.84

Even under most favorable load conditions the water rate of the unit under consideration was found to be approximately 50 lb. per kw-hr. Accordingly, with the above annual electrical energy requirements of 408,000 kw-hr. at least (408,000 times 50) 20,400,000 lb. of steam would have been called for per year; thus, with an evaporation of 7 lb. of water and a coal cost of $6.00 per ton, at least 1455 tons of coal would have been required at a cost of $8730.00 a year.

Probable total costs to be expected as then appeared,

Fuel	$8730.00
Fixed charges	3483.84
Total	$12,213.84

and with a unit cost of ($12,213.84 divided by 408,000) $0.0299 per kw-hr.

So much for the all energy purchased plan and the all energy generated plan. We will next consider the plan of generating a part of the energy and purchasing the rest. This, however, involves a more extended discussion than can be given here, so this aspect of the problem will be considered in a subsequent article.

Uni-Pass Reclamation of Electrical Oils

MAINTENANCE of oil for transformer or oil-switch use in good condition is essential. For this purpose, filtration, settling, centrifugal separators, heating, absorption have been used in various combinations.

Requirements for oil purification and reclamation are: Removal of all water in every form, of dissolved air and gases, of all sludge, of all suspended matter whatever the size. No foreign matter should be introduced into the oil during the process and a single pass through the purification apparatus is desirable for the sake of efficiency and time saving. To meet these requirements, S. F. Bowser & Co., Inc., is offering the Uni-Pass for reclamation of electrical oils, embodying results from its own research laboratories and from investigations by independent electrical and chemical engineers. It is made in portable or stationary form with continuous capacity of 400 gal. per hr. which is stated to be able to meet the requirements of all cases due to passing oils through but once to purify them. Two oil connections and one electrical connection are all that is needed to make the equipment ready for operation.

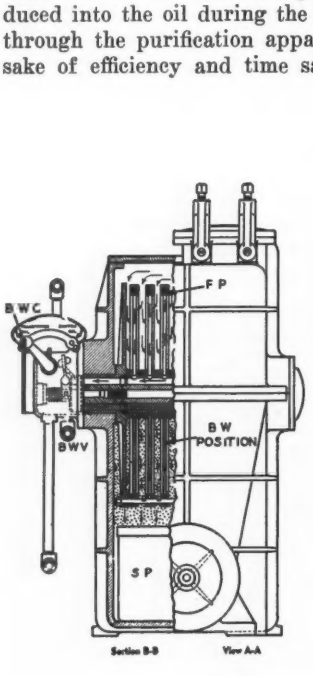


FIG. 1

FIG. 1. CROSS SECTION OF FILTER ELEMENT

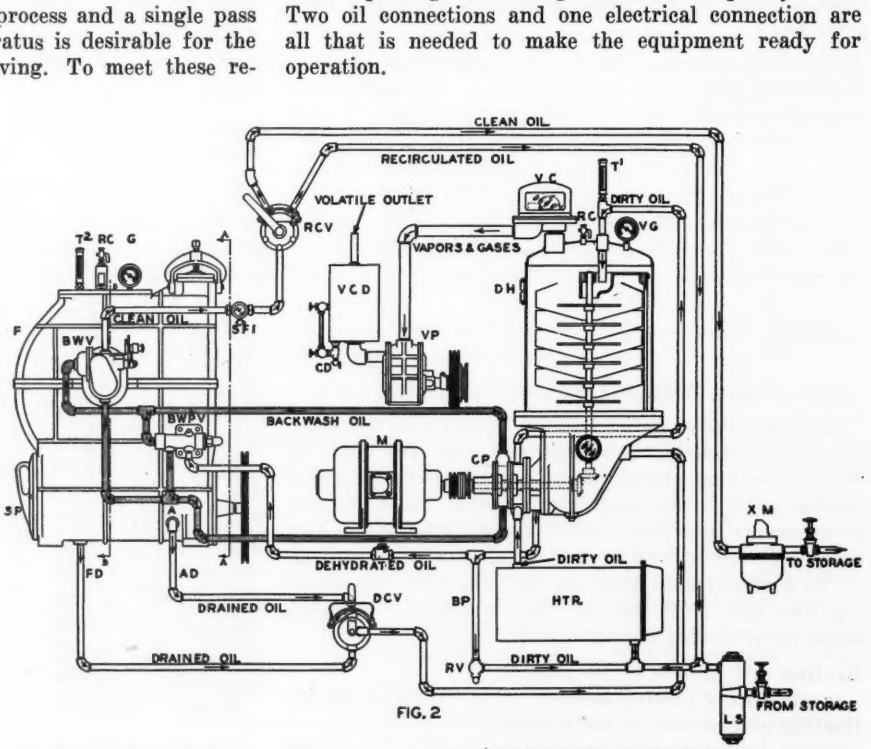


FIG. 2

FIG. 2. OPERATION DIAGRAM OF UNI-PASS

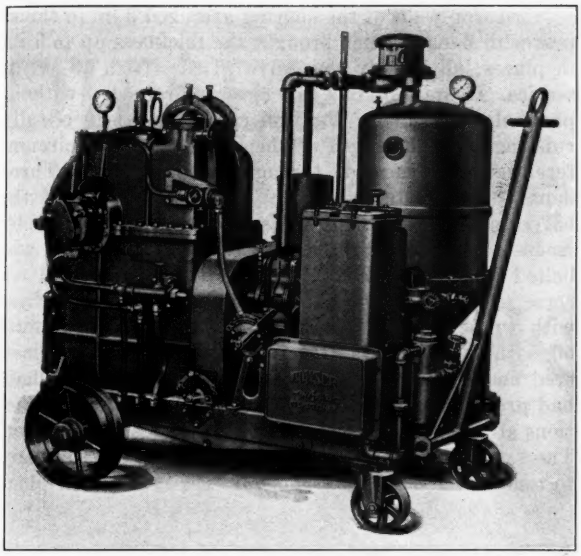


FIG. 3. OPERATING SIDE OF PORTABLE UNI-PASS

Operation is as indicated on the accompanying diagram, Fig. 2. Incoming dirty oil enters from storage through the line strainer, LS, which removes rust, coarse foreign matter and large globules of water to a sump, whence it is removed through a drain cock. Next, by an electric heater, Htr, temperature is raised to 100 to 120 deg. F., heating elements being individually controlled and completely submerged so that the required temperature may be obtained with minimum current and overheating avoided. Temperature is shown by thermometer T^1 in the dirty oil line above the dehydrator, to which oil is transferred by one of the centrifugal, motor-driven pumps CP.

In the dehydrator, DH, where a vacuum of 28 to 29 in. is maintained, the oil is dispersed and atomized by a series of six revolving disks driven from the pump shaft at 1200 r.p.m. From each disk the oil flows through the center of its pan to the disk below, thus being atomized six times to allow any water in the oil to flash into vapor which with gases escapes from the top of the dehydrator into vacuum chamber, VC, and is drawn off by vacuum pump, VP, into the vapor condenser, VCD. Volatiles pass to atmosphere through the outlet and condensate is drawn off through the drain, CD.

Dehydrated oil collects in the sump and is conveyed to an all metallic filter F for removal of suspended and sedimentary matter in a single pass. This filter, Fig. 1, has a series of eight twin, non-corrodible porous plates FP, 21 in. diam. by ¼ in. thick, forming infinite minute passages to accomplish filtration. Even with provision for removal of most minute particles of matter, passages are kept free by continuous backwash.

Lengthwise through the shaft on which the plates are mounted are six equally spaced passages opening into the clean-oil chamber and with radial ports leading in from the six segments between twin filter plates, formed by radial spacing grids. Thus each longitudinal shaft passage leads from one series of eight twin segments to the clean-oil chamber. In this chamber, seating against the end of the drilled shaft, which projects into the chamber, is a stationary flat-disk backwash valve, BWV, Fig. 1, having a single port vertically below the center line of the shaft which admits clean oil from the backwash pump discharge line to the segments in their lowest position, BW Pos'n. This backwash by clean oil dislodges dirt and sludge which have accumulated on the faces of the segments during the filtration period when the segments were discharging freely to the clean-oil chamber. Excess of backwash pressure over filtering pressure is maintained by the backwash pump and a differential pressure valve, BWPV, Fig. 2. Backwash oil is returned to the filter chamber and again filtered. Thus at all times, five segments are acting as filters and one is being backwashed, the plates making one revolution in 2 min. Below the backwashed segments is a large pan, SP, to collect sludge and carbon removed from the filter plates. From the clean-oil chamber, oil passes through a sight flow indicator, SFI, the recirculating valve, RCV, and the Xacto meter, XM, to storage.

Filter pressure is shown by gage G on top of filter F and vacuum in the dehydrator by gage, VG. At the bottom of the filter is a compartment A in which an agitator operates to prevent concentration of dirt or lint at the inlet. This as well as pumps and dehydrator disks are driven from one motor, arrangement of the parts being seen in Fig. 3, with all current handled through a single hand-operated controller so that no heating units can be on when pumps are stopped.

For handling switch oil, to remove the microscopical carbon particles, which would pass even the minute pores of the metal filter disks, a pre-coat of porous filter-aid is introduced into the filter compartment by means of the cover on top. This covers the filtering surfaces of the plates to ensure removal of the carbon particles, backwash control lever, BWC, being moved to discontinue backwashing so as to preserve the coating of filter-aid, all six segments acting as filters. While applying the filter-aid, the recirculating valve, RCV, is set so that oil passes around through the system, with intake and discharge valves closed, until the filter-aid is distributed over the disks, a matter of a few minutes' operation.

Welding and Cutting in the Hydro Plant

PROPER EQUIPMENT HELPS IN CUTTING REPAIR AND RENEWAL COSTS. BY D. R. PRATT*

HYDRO-ELECTRIC power plants use the cutting torch and welding process to excellent advantage in a number of interesting ways to reduce materially repair and maintenance charges. Figure 1 shows a badly broken runner in a horizontal, low head, reaction turbine that was restored to service by welding. This unit was located in a plant in a northern district where ice had to be guarded against. In spite of steel trash racks across the forebay, ice and flotsam occasionally forced their way through and into the turbine. The runner shown had eleven vanes torn out and a number of the remaining ones fractured. The installation of a new runner would have made it necessary to disconnect the generator, remove one-half the coupling on the turbine shaft, pedestal bearing, two bulkhead stuffing-boxes and the complete dismantling of the entire penstock.

*The Linde Air Products Co., New York, N. Y.

The method that was used in repairing the runner was to remove the top casting from the turbine unit. This exposed enough of the runner to permit the installation of new vanes by oxwelding. Arrangements were made with the turbine manufacturer to furnish individual cast iron runner blades. The broken blade ends on the runner were then chamfered as shown and the new blades cut to the shape of the broken vanes. The

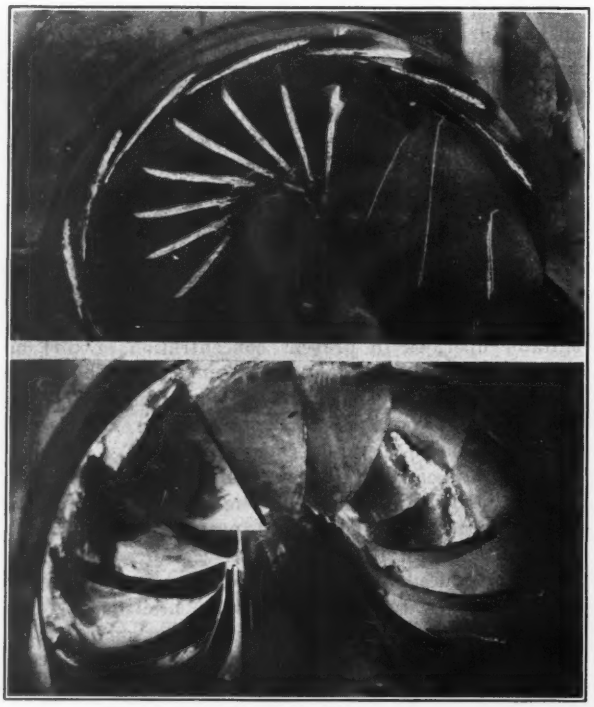


FIG. 1. (ABOVE) A BROKEN TURBINE RUNNER READY FOR REPAIR (BELOW) THE RUNNER REPAIRED BY WELDING AT A SAVING OF $600

new blades were then oxwelded, using manganese bronze welding rod. All welds were of the single vee type and were sufficiently smooth to make grinding or dressing unnecessary.

Figures based on previous experience show that the total cost of replacing a runner of this type is approximately $900, of which $400 is the cost of the new runner. The total cost of the repair by oxwelding was roughly $225, of which $165 was for materials and $60 for labor resulting in a net saving of over $600; moreover the unit was out of service less than 25 per cent of the time which would have been required for the installation of a new runner.

Another application of the oxy-acetylene process in the hydroelectric field that resulted in a material saving for a utility company was the removal of the lower bearing housing of a 10,000 kv-a. vertical water turbine shown in Fig. 2. The reason for removing the bearing housing was to replace the worn lignum vitae bearing with a rubber-lined guide bearing. It was first thought that it would be necessary to dismantle the entire unit, from penstock to generator floor, until the plant management decided to consult an oxy-acetylene service operator. After a thorough investigation, he concluded that it was feasible to cut the barrel and agreed to instruct the plant welders in the proper procedure.

Cast-iron walls of the housing averaged 3 in. in thickness with flanges which brought the thickness up to 5 in. in places; all heavily covered with rust from 19 yr. of service. In spite of this, the cutting proceeded without particular difficulty. The first cut was made vertically running the full length of the barrel. Then a circumferential cut was made through the midsection. Three more vertical cuts were made in the lower half of the barrel and the quartered sections lowered to the floor by means of a chain fall. The upper half of the barrel was bolted in place. The nuts holding the housing had become so corroded that it was impossible to move them with wrenches. The operator accordingly cut the nuts off with the blowpipe after which the section was lowered and treated in the same manner as the lower half had previously been. The photograph shows the cut sections after they had been removed to the generator floor. The saving in time that resulted enabled the company to remove the old barrel and have the new one in place

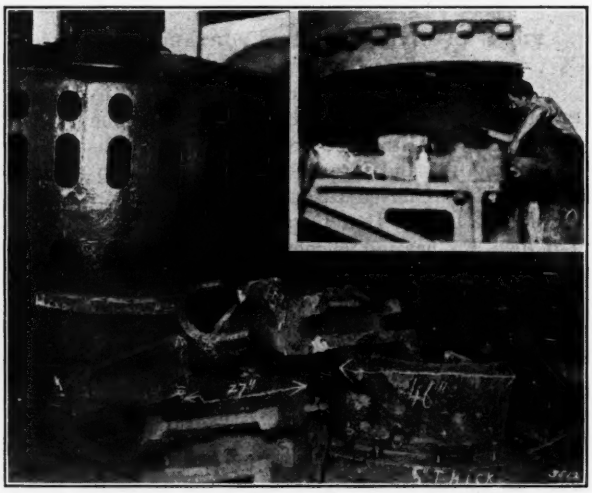


FIG. 2. (UPPER CORNER) CAST IRON BEARING BARREL THAT WAS REMOVED WITHOUT DISMANTLING THE UNIT (BELOW) SOME OF THE SECTIONS REMOVED AFTER BEING INSTALLED 19 YR.

in a week's time. Time saving is a matter of vital importance when it becomes necessary to shut down a unit of this size.

Largest High-Speed Turbine

WHAT IS CLAIMED to be the largest steam turbine so far constructed to run at 3000 r.p.m. has recently been completed by the Brown-Boveri Co. of Baden, Switzerland, for the new electric power station at St. Denis, Paris. The machine is of 50,000 kw. capacity and is designed to be operated with steam at a pressure of from 785 to 1000 lb. per sq. in. and at a temperature of from 842 to 942 deg. F. Progress that has been made in high-speed turbine design and construction may be gaged from the fact that at the end of the war in 1918 the largest 3000-r.p.m. turbine had a capacity of only 8000 kw., its weight being 22 lb. per kw. as against only 16½ lb. per kw. in the case of the latest machine. Again, the capacity per square foot of space occupied has been increased from about 23¼ to 37¼ kw.

DIESEL ENGINE UPKEEP

PART XIX. AIR FILTRATION REDUCES WEAR, AIDS LUBRICATION AND BENEFITS COMBUSTION. FILTER TYPES AND MAINTENANCE. INSTALLATION METHODS. INVESTMENT ECONOMICS.

BY EDWARD J. KUNZE

DIRT DRAWN INTO a Diesel engine with its air supply is detrimental to operation in a number of ways. Because of its abrasive action, grit not only destroys all bearing surfaces, such as cylinder liners and piston rings, but also impairs valve action and valve seats. Soot combined with grit forms a gummy mass that makes valve action sluggish and may prevent proper combustion of the fuel oil and lead to power losses due to carbon deposits on piston heads. Analysis of deposits removed from cylinder and piston heads shows that over 90 per cent of it is dust that has been drawn in with the air and combined with the lubricating oil.

Consisting as it does largely of relatively non-combustible mineral matter, dirt taken in with the air supply may act as a cementing material, which becomes baked hard on the hot surface of the piston and cylinder, destroying their heat conductivity.

Lubrication is impaired by introduction of foreign mineral matter not merely because of the formation of gummy deposits in the system but principally because gritty materials break the oil film, which it is so necessary to maintain between moving parts to prevent seizure, with resultant cutting and destruction of the bearing surfaces.

AIR FILTER TYPES

Three methods of air cleaning are in use: direct filtration, centrifugal action and impingement. In most cases, air filters employ combinations of two or more of these methods. Direct filtration is accomplished by the intervention of some medium such as wool felt packed more or less tightly in a retainer such as shown in Fig. 1, depending upon the degree of cleaning desired and the permissible resistance.

Another kind of direct filter wraps a filter fabric around a frame of loops projecting radially from a central core as shown in Fig. 2. In use, the air enters the outside surfaces of the loops and proceeds through the core to the engine.

This filter is cleaned as shown in the figure by inserting a special bolt through the core, attaching an air blast to this bolt and slowly turning the bolt as shown, thus concentrating the air blast at the various loops in succession.

Care should be observed to keep the filter material free from oil or similar material. Thorough washing in high test gasoline will remove oil or soot readily. The last washing should be in clear gasoline and the material allowed to dry completely before being returned to service. This make of filter is also produced in panel form.

Centrifugal action to throw off the heavier particles is sometimes employed, as shown in the headpiece of this article. This cleaner has a movable wheel carrying blades; other centrifugal cleaners have no moving parts.

Air filters of the impingement class are sometimes of one or more panel cells, which may be supplied with a number of filter sheets as shown in Fig. 3. These sheets

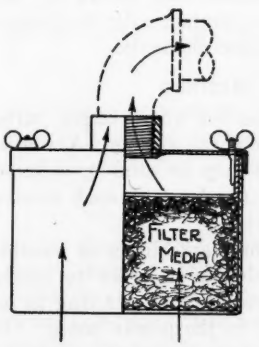


FIG. 1. DIRECT FILTRATION TYPE OF AIR FILTER

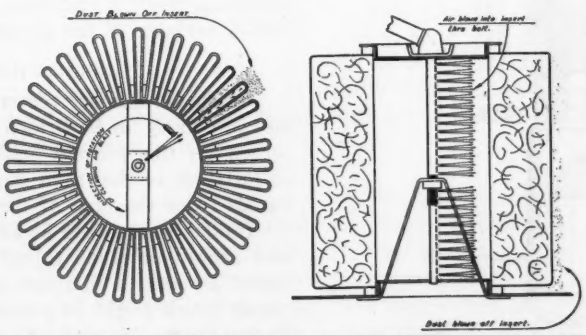


FIG. 2. LOOP FABRIC AIR FILTER SHOWING METHOD OF CLEANING

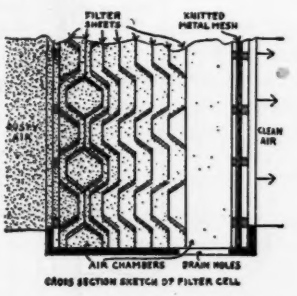


FIG. 3. CROSS-SECTION OF FILTER CELL SHOWING HOW DUST IS CAUGHT ON THE VISCOUS COATED FABRIC SHEETS

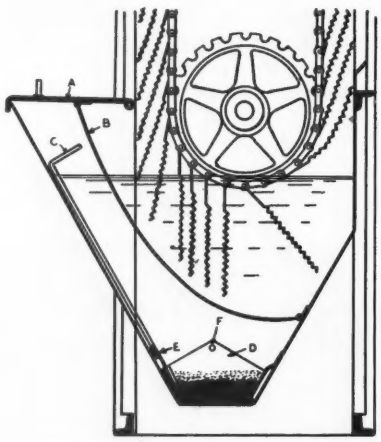


FIG. 4. AUTOMATIC-PANEL TYPE OF AIR FILTER
A—Hinged reservoir cover. B—Flexible guard bands which provide clearance for removing pan. C—Extension handles. D—Sediment pan. E—Hooks to engage front edge of reservoir. F—Handle for carrying sediment pan.

are of fabric, treated with a viscous substance to hold the suspended particles, as the air to be cleaned passes through the fabric. In using this kind of filter it is sometimes best to treat only the last few filter sheets with the viscous material. This avoids too rapid clogging of the first few sheets, distributes the work among sheets more uniformly, thus reducing the resistance to flow, increases the capacity of the filter, and facilitates cleaning of the cells.

Approximately one gallon of viscous material is required per cell per year. Especially prepared material for this purpose is on the market. Cleaning and recharging of this type of filter is accomplished by lifting out a cell section, dipping it into a special tank about three-fourths full of hot water in which 1½ lb. ordinary washing soda has been dissolved. The dirty cells are soaked in this solution for 5 min. then moved up and down vigorously to force the solution through the filter media.

When removing cells from the tank, the floating dirt should be brushed to one side and the cell taken out edgewise, surplus water drained off, then recharged by being dipped into a tank containing about 10 gal. of the viscous material. After recharging, the cell should be permitted to drain for at least 12 hr. before being replaced in service. Cleaning may be accomplished also by blowing steam at about 100 lb. pressure through the dirty cell for about 10 min. Each filter cell should be cleaned and recharged at regular intervals which vary from two to eight weeks, depending upon the service and dust conditions.

Continuous Cleaning Makes Process Automatic

Automatic cleaning of a multi-panel air filter of this type is accomplished as shown in Fig. 4, the panels being lowered and drawn continuously through the bath of viscous charging material as shown. The filter curtain is rotated automatically by an electrical control, making one complete rotation every 48 hr. under normal dust conditions. Under severe conditions the rate of rotation is increased to the point at which the air resistance remains constant.

FIG. 5. STREAM-LINE TYPE OF IMPINGEMENT AIR FILTER

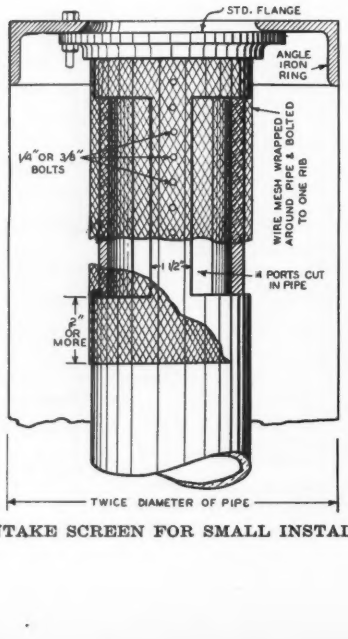

STD. FLANGE
ANGLE IRON RING
¼" OR 3/8" BOLTS
WIRE MESH WRAPPED AROUND PIPE & BOLTED TO ONE RIB
1 1/2"
4 PORTS CUT IN PIPE
6" OR MORE
TWICE DIAMETER OF PIPE

FIG. 6. INTAKE SCREEN FOR SMALL INSTALLATIONS

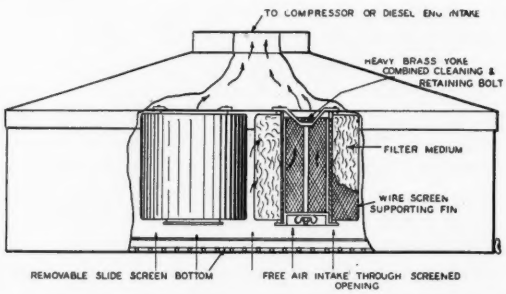

TO COMPRESSOR OR DIESEL ENG. INTAKE
HEAVY BRASS YOKE COMBINED CLEANING & RETAINING BOLT
FILTER MEDIUM
WIRE SCREEN SUPPORTING FIN
REMOVABLE SLIDE SCREEN BOTTOM
FREE AIR INTAKE THROUGH SCREENED OPENING

FIG. 7. METHOD OF INSTALLING PROTECTOMOTOR AIR FILTER OF THE HANGING TYPE

Dust and dirt washed from the panels settle to the bottom and deposit in a removable sludge bucket, Fig. 4, which is lifted out by extension handles without interruption to the process. This sludge should be removed at intervals which vary from three to six months.

In another form of impingement filter the elements are given a stream-line cross section, as shown in Fig. 5, to offer a minimum resistance. With this filter the air is cleaned partially by impingement and partly by the scrubbing effect it undergoes, in contact with the viscous coated surfaces of the stream-line elements.

Installation Methods

Intake screens are recommended where larger particles are likely to be drawn into the system. A simple screen for this purpose which may be used by a small installation is shown in Fig. 6. Area of each section equals twice the area of the pipe.

Intake lines should be as short and direct as possible and should be made to outside air in order to obtain cooler air and to eliminate possibility of drawing in oil vapor which might be present in the power house. Oil vapor drawn in with the air supply might cause an explosion.

Air filters installed outside the power house should be properly protected from the elements but should be accessible for cleaning. Hanging type of filter is installed as shown in Fig. 7. Instead of hanging, the filter may rest upon beams, the air being drawn in at the top and discharged to the engine at the bottom.

Panel type air filters may be installed on the ground level outside of the engine room as shown in Fig. 8. The

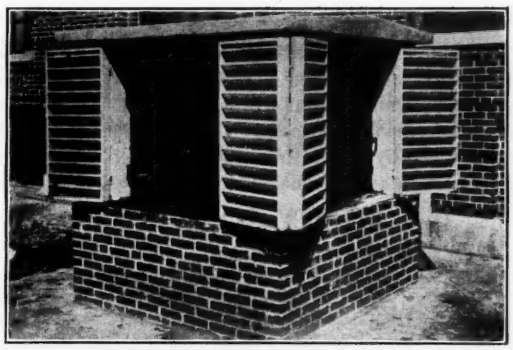


FIG. 8. INSTALLATION OF PANEL TYPE OF AIR FILTERS

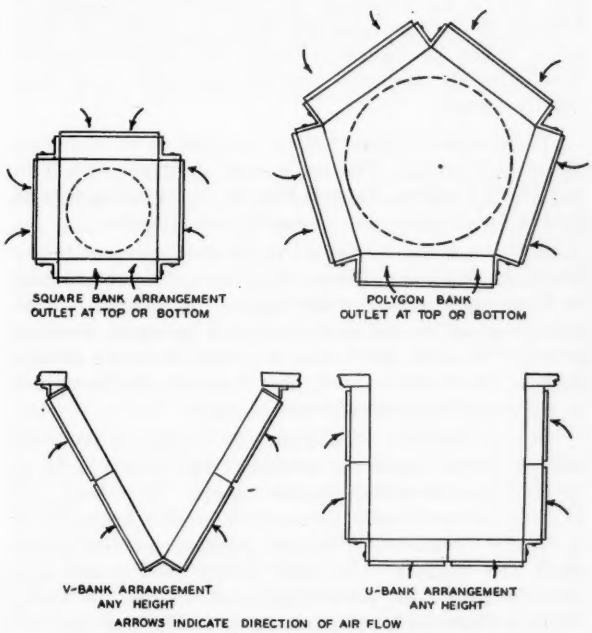


FIG. 9. VARIOUS METHODS OF GROUPING AIR FILTER PANELS

panels may be arranged in any convenient grouping, as in Fig. 9. Direct attachment of a panel and other type filters to an engine in a small plant may be made.

NICKEL has been produced in sheets so thin that print can be read through five thicknesses, placed a few millimeters apart. The process is to electroplate a layer of nickel on copper, then plate copper onto the nickel, then dissolve the copper from both sides, thus equalizing the stresses as the copper is removed.

Rehabilitation of Charles City Plant

IMPROVEMENTS and changes intended to modernize the Charles City, Ia., plant of the Iowa Public Service Co., are practically completed.

An extension of the old building houses a 1500-kw. Westinghouse turbine-generator set, exhausting to an Ingersoll-Rand surface condenser. Steam at 400 lb. pressure for this turbine is generated in a Heine type water-tube boiler supplied by the Combustion Engineering Co. An Elesco superheater is used and a Coxe stoker installed under this boiler. The new concrete chimney is 175 ft. high. A Schubert-Christy cooling tower cools the condenser circulating water.

Coal is unloaded with a P. & H. traveling crane and clamshell. Automatic Link-Belt equipment elevates it to the storage hopper above the stoker. Before it goes

REMODELED CHARLES CITY PLANT SHOWING COOLING TOWER, AUTOMATIC SKIP HOIST AND NEW CHIMNEY

to the stoker, all coal is weighed by a Buffalo weighing hopper.

A bank of transformers outside the power house connects this station with others on the loop. Waterloo, with a large station burning powdered coal, and Nashua, with a hydroelectric station on the Cedar River, are parts of the loop.

This Charles City station furnishes power for the Oliver Farm Equipment tractor factory as well as for the service load. In case of outside disturbance, automatic switching cuts the turbine set over to the Oliver load alone, so that the factory always has power.

MICHAEL FARADAY, who was an experimenter in metallurgy as well as in electromagnetism, is revealed as the first developer of stainless steel by samples of alloys of iron with platinum discovered among his effects which have been stored at the Royal Institution. Faraday also investigated alloys of steel with nickel but did not add enough chromium to produce stainless steel in that way.

250,000-Sq. Ft. Greenhouses Served by 800-B-Hp. Plant

WHAT IS BELIEVED to be the largest and most modern boiler plant serving any greenhouse in the country is installed at the greenhouses of C. F. Baker & Sons of Utica, New York.

As pointed out by Frank J. Baker, the general manager of this organization, growing of various types of plants in a greenhouse of this size necessitates an absolutely reliable source of steam at all times, especially in the climate where the plant is located. It is evident that if the greenhouse were completely filled with blooming plants all ready, let us say, for the Christmas business, and a sudden drop in temperature should occur, the damage caused by failure of any part of the steam supply system, especially by a breakdown in the boiler house, would doubtless result in the ruin of the entire crop. As Mr. Baker points out, such an occurrence might prove a major disaster to any florist and it has been known to happen on more than one occasion.

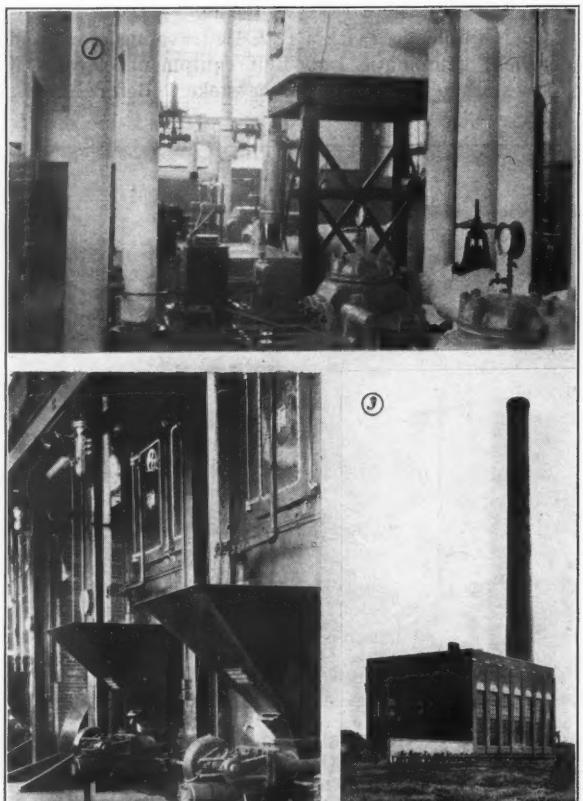


FIG. 1. PUMP ROOM AT NEW BAKER GREENHOUSE PLANT
FIG. 2. FOUR STOKER-FIRED H.R.T. BOILERS RATED AT 800 HP.
FIG. 3. EXTERIOR VIEW OF PLANT

The object of building a boiler plant of a really commercial character to serve these greenhouses was primarily to eliminate the worry and anxiety under which many florists labor during cold weather. It was shown by the designing engineer and the various manufacturers of equipment that from the financial standpoint, the new boiler plant could be made to pay for itself in a short time. According to the owners, however, its performance has been so satisfactory and its economy so good that this estimated period will be materially shortened and besides this the feeling of anxiety during cold weather has been entirely eliminated, a factor which, according to Mr. Baker, is extremely worthwhile, although difficult to express in financial terms.

The boiler plant makes steam at 150 lb. pressure which is reduced by an Atwood & Morrill regulating valve for distribution in the 12-in. main headers running to the various sections of the greenhouse; here it is again reduced by regulating valves to 10 lb. pressure for distribution in the greenhouses.

Four Titusville Iron Works horizontal tubular boilers are installed as shown in Fig. 2. Two of these are of 250 hp. capacity each and two of 150 hp. capacity each. They are fired by Detroit single retort stokers. Coal is elevated by a bucket elevator to a 200-t. steel bunker over the boiler room firing aisle and a weigh larry distributes the coal from the bunker to the stoker hoppers. All coal handling equipment was supplied by Beaumont Mfg. Co. A United steam jet ash conveyor running in front of the boilers takes the ash to a storage bin from which it can be loaded to trucks for further disposal. West Virginia screened nut and pea coal is the fuel usually burned.

The complete piping system was put in by Brindleis Steam Fitting Co. The boilers are equipped with Yarway blowoff valves, Yarnall-Waring water columns with Sesure water gages and Diamond soot blowers.

A Clarage No. 90 forced draft fan produces forced draft, the fan being driven either by a GE motor or by an Engberg 8 by 7-in. steam engine. A Ruggles-Klingemann step action regulator actuated by steam pressure governs the fan speed and a Cutler-Hammer control governs the motor. Gases pass from the boiler uptake to a Summerhays radial brick chimney.

Boiler feedwater consists mostly of returns from the heating system under the control of two Union 12 by 12 by 16-in. reciprocating vacuum pumps. It is heated in a Cochrane open feedwater heater of 1500 b.hp. capacity by steam exhausted from the pumps and the forced draft fan engine. The main boiler feed pump is a Gould's 108-g.p.m. centrifugal unit driven by 41-hp. Whiton steam turbine operating at 2800 r.p.m. and exhausting at 5 lb. back pressure to the feedwater heater. A Cochrane flowmeter measures the boiler feedwater and Taylor and Bristol recorders and other instruments in the greenhouses record steam flow and temperatures. All piping is insulated with Johns-Manville 85 per cent magnesia pipe covering.

NEWSPAPERS REPORT that bloodless brain surgery by means of electric sparks instead of the knife has been made possible by a new German invention. Removal of any part of the brain by electricity, hitherto believed impossible because of the effect of electric current on the nerves, has been solved by German scientists by using currents of extremely high frequencies.

Corrosion by Flue Gases

INVESTIGATION of the action of flue gases on boiler room equipment has been carried out by the Engineering Experiment Station of the University of Illinois both by surveys in a number of operating plants and by laboratory experiment. The results are given in Bulletin No. 228, which can be obtained from the Station at Urbana, Ill., for 65 cents. Among the conclusions reached and phenomena observed, the following are of special interest.

Surveys were made in 15 plants using stokers, pulverized fuel furnaces and gas firing. Pressures ranged from 225 to 700 lb.; steam temperature from 580 to 750 deg. F. Furnace walls were of refractories, air-cooled and water-cooled, with and without economizers and air preheaters. The survey covered, therefore, all types of boiler plants.

As to operation, CO_2 ranged from 11 to 15 per cent. Temperature of gas at inlet to economizer from 544 deg. F. to 1050 deg., at outlet from 280 to 510 deg.; water inlet temperatures from 269 to 425 deg.

For air preheaters, inlet gas temperature range was 325 to 475 deg.; outlet gas temperature, 230 to 390 deg.; air temperature, 175 to 380 deg.

Fuels used varied from eastern bituminous with one per cent moisture and 9.7 per cent ash to a midwest coal with 20 per cent moisture and 18.9 per cent ash.

Fuel ranges and operation were, therefore, diversified to cover practically all conditions to be met in practice.

Effect of Sulphur

While high sulphur content did not always result in corrosion, especially in pulverized fuel plants, corrosion was most frequent with sulphur over 2 per cent and none when sulphur was under 2 per cent. Also corrosion was greatest with coals high in ash and with high draft, often accompanied by slag formation on tubes.

Tests of gases showed that of the sulphur in the coal, 70 per cent was carried into the gases in the case of stoker-fired plants and 90 per cent with pulverized fuel but sulphur trioxide concentration in the gases is lower in the case of pulverized fuel.

At dew-point temperature, which was found to vary from 115 deg. to 151 deg., depending on the water vapor in the gases, corrosion is most severe because a liquid film will be deposited on metal surfaces which will carry corroding agents in solution and these will have close contact with the metal. At lower temperatures, rapidity of chemical action will be reduced and at higher temperatures the liquid film will not form. Dew formation depends on the temperature at the metal surfaces rather than through the body of the gas and will be at higher temperature as sulphur content in the gases is increased. Combination of a high dew-point and a scale containing feric sulphate was the condition resulting in greatest corrosion.

Presence of moisture due to leaks, as at the ends of economizer tubes, and collection of dust are, therefore, factors which increase corrosion.

Locality of Heater Corrosion

As to locations, in some cases maximum corrosion was found in preheaters at the front of the air intake when temperature of metal was 300 deg. or less. At higher temperatures, corrosion was slight, if any. In other cases, corrosion was greatest near where gases enter the heater, extending but a short distance from that location. It was found that for clean surfaces, preheater metal temperature at the cold end would be the average of air and gas temperature while, at the hot end it would be that average less 10 deg. F. For dirty surfaces these metal temperatures would be lower.

Preheater corrosion can be reduced by recirculation of heated air and by parallel flow arrangement but both remedies reduce the heater capacity. Erosion of preheater surfaces aids corrosion, hence reduction of ash particles before gases enter the preheater will reduce both effects.

Economizer Corrosion

In economizers, corrosion is most severe where leaks develop as at rolled joints of tubes. Even a slight leak will rapidly increase and corrosion will spread to nearby tubes which are wet by steam or mist and become coated with flue dust. The corrosion starts when metal surfaces are at 260 deg. F., or below, surfaces becoming rough and pitted. Moisture from soot blowers, incorrectly operated, may add to corrosive effect. Tube temperature at the cold end of an economizer will be about water temperature plus 10 deg. and, at the hot end water temperature plus 40 deg.

Aids to lessening economizer corrosion are found to be, use of high-grade coal, low in sulphur and ash, elimination of cold water strains, and baffling to avoid cold air strains, thus reducing the formation of leaks. Arrangement of the newer designs with all joints outside the path of flue gases largely stops tube loss but some general corrosion still exists.

With gas flowing vertically across tubes placed in staggered arrangement, corrosion was greatest at points above and below the horizontal diameters of tubes, where dust collection was thickest.

Resistance of Metals

Investigation of metals to resist corrosion showed that chromium steel, 14 to 30 per cent chromium, would resist the action of ferric sulphate. Addition of nickel, under 20 per cent, was ineffective. Stainless iron known as 18-8 gave better results than nickel-chromium alloys with percentages 20 and 20. At 200 deg. F., lead was attacked by the gases, indicating that the sulphuric acid concentration in the ash deposits was 65 to 80 per cent. Copper alloys were badly corroded. While enameling of tubes was an effective protection against corrosion, mechanical difficulties seem too great to make this economical.

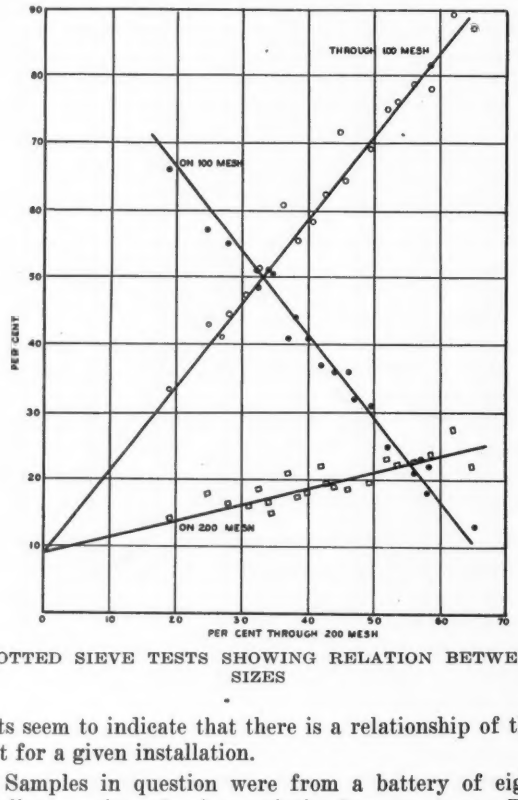
As to preparation of coal, washing to remove the heaviest 10 per cent, in the case of most Illinois coals, took out 25 per cent of the ash and 25 to 30 per cent of the sulphur. Removal of an additional 10 per cent of coal weight removed only 4 per cent more of the ash and 10 per cent more of the sulphur, hence would hardly be considered economical.

Contracts have been signed by Board of Public Affairs, operating Orrville Municipal Utilities, for a new 1500-kw., 1875-kv.a., turbo-generator and surface condensing equipment. Improvement of the light plant is being financed out of earnings; foundations and other equipment will be installed by city forces.

Readers' Conference

Relative Sizes and Proportions of Coal Particles

MUCH HAS BEEN written on the desirable fineness of pulverized coal, the pulverizing characteristics of the various types of mills have been investigated, but to date the writer has seen nothing published on the relative proportions of the various sizes existing in the pulverized coal. In fact, statements have been made intimating that such relationships do not exist, but continued observations of the results of progressive screen



PLOTTED SIEVE TESTS SHOWING RELATION BETWEEN SIZES

tests seem to indicate that there is a relationship of this sort for a given installation.

Samples in question were from a battery of eight duplicate unit pulverizers of the hammer type. The illustration shows the results of tests, plotting the percentages on 100-mesh, through 100-mesh and on a 200-mesh against the percentage passing through 200-mesh. The results plotted were taken at random from many samples from the entire battery of machines, in various stages of wear. The figure shows a straight line relationship between the various sizes.

Empirical equations can be set up representing the relationship as follows:

A = Per cent remaining on 100 mesh
B = Per cent passing through 100 mesh
C = Per cent remaining on 200 mesh
D = Per cent passing through 200 mesh

and $B = C + D$ and $A + B = A + C + D = 100$ per cent, by our hypothesis.

Equations of the lines on the figure work out to be:

$$A = 91 - 1.235\ D \quad (3)$$
$$B = 9 + 1.235\ D \quad (4)$$
$$C = 9 + .235\ D \quad (5)$$

An overwhelming proportion of samples taken over a period of months agree rather closely with the plotted relations. Those not in agreement are so few as to be negligible, indicating, perhaps, faulty sampling. It is to be regretted that more complete screen tests were not made, so that at least the percentage remaining on a 50-mesh screen could also be tabulated, although it is doubtful whether this item would show any relationship.

It is not meant to set up these equations as holding for all cases but rather to show that for a given installation, or even for a given type of machine, such relations do apparently exist and can be determined as is done in this case.

Just what effect the type of coal used would have on relationships such as these is not known, nor is the behavior of the same type of machine in different installations. Further information along this line should be quite interesting to users of pulverized coal.

Lima, O. THEO. JAMES.

Fixed Charges vs. Operating Expense

L. F. ROGERS' communication in the November 15 issue is suggestive of the misapprehension that exists in so many people's minds as to the real meaning of the charges that are ordinarily classed as fixed.

Fixed charges seem to be, as Mr. Rogers says, a stumbling block and over it many a plant engineer's fond hopes trip and fall into oblivion. This should not be so because the fixed charges on or the book value of existing equipment have no effect in the evaluation of a new project.

Any plant improvement must be made for one of three reasons:

(1) To replace worn-out equipment the operation of which has become either prohibitively expensive, unreliable or physically impossible.

(2) To accomplish a saving in operating cost by the installation of modern equipment in place of old equipment when the old equipment is still in good operating condition but relatively inefficient.

(3) To raise the standard of the plant as a matter of policy.

Only the second case need be considered as requiring economic justification. The first case is compulsory and will require only comparative evaluation of various methods of replacement. The third case is a matter of policy and the amount of saving from existing operating costs is not a consideration.

When a plan is developed of the nature indicated in the second classification the book value or fixed charges on equipment to be scrapped does not enter into the evaluation problem at all.

For the purposes of this discussion a proposed improvement is assumed in which the book value of equipment to be scrapped is $10,000 and the rate of

fixed charges 13 per cent. If the improvement is carried through the book value of the existing plant must be reduced by $10,000 which will reduce the annual fixed charges on existing plant by $1300. But this $10,000 written off from the book value of the existing plant must be added to the cost of the plant improvement increasing the fixed charges on it by $1300. These two charges balance each other and the effect is the same as though the book value of equipment scrapped were entirely ignored.

The method of figuring and applying fixed charges is purely an accounting matter. Books are kept to show whether or not an institution is making money and to determine the amount of profit or loss. A business starts with certain property and equipment representing a sum of money invested. At some future time the equipment will have to be replaced and the money for this replacement represents what might be called a deferred liability that should be provided for out of income. It is obvious that the only safe and wise way to provide for this replacement is to lay away a sum each year so that sufficient money will be available to pay for a replacement when it becomes necessary. No well managed company will allow any large sum of money to lie idle in its treasury but will rather put it out at interest in some form or other. This depreciation reserve fund may be used to retire bonds, it may be invested in securities, or used in any other way that the management sees fit. If it is used to reduce corporate indebtedness, the company's annual interest charge will be reduced. If it is invested in securities it will presumably earn dividends. It may be assumed that in any case the depreciation reserve will either earn or save interest. It would therefore seem that the sinking fund method is the proper one for establishing the depreciation rate. The particular method used, however, for determining the rate used in charging depreciation is of no special interest to the plant engineer.

It is sometimes argued that depreciation and interest charges are theoretical, that they are not immediate out of pocket expenses and therefore should not be included in figuring costs of operation. Depreciation, however, is an out of pocket expense just as much as is the cost of coal. If because of an extremely favorable market a company bought coal enough to last for 20 yr. it would not charge the whole cost to the year when the coal was bought but would charge each year's operating costs with the quantity used during that year. This yearly charge would be depreciation. Money to purchase the 20 yr. supply of coal would have to be borrowed either from outsiders or from available funds in the company's treasury, and the company must pay interest for borrowed money or suffer a loss of interest from money removed from the treasury funds.

Depreciation and interest are real expenses and no company can operate successfully, except by luck, without giving them full weight.

The expense of maintenance is a part of operating costs and is in no sense a part of fixed charges. Any system of calculating depreciation is based on the assumption that equipment is maintained in the best possible condition throughout its useful life. Some companies make a practice of setting aside a fixed sum each year to cover maintenance costs and then crediting the reserve so created with the cost of maintenance each year. The amount of this reserve varies up and down from year to year and if properly set up in the first place is never great. It seems to be generally recognized among accountants that maintenance costs should not be classified or treated as fixed charges but rather as distinctly operating charges.

Philadelphia, Pa. WALTER P. GAVIT.

Stock Packings for All Purposes

IN 25 YR. EXPERIENCE the writer has found but one plant with an all-inclusive stock of packing in the tool locker. The chief chances to be a Scot, withal, carefully sensible with his requisitions.

Here we find an orderly array of boxes containing 12½ ft. of from ⅛ to 2-in. spiral packings to fill space between rods and stuffing-box walls. Air compressor packing with asbestos base to withstand dry heat and reels of round graphite treated asbestos, 1/16, ⅛, ¼, 5/16, ⅜, 7/16 and ½-in. yarn for the packing of valve stems.

In neat little drawers the chief has ⅝ and ¾-in. gage glass packing rings and a few ½-in. for the donkey boiler water column. ¼, ⅜, ½, ¾, 1, 1¼ and 1½-in. valve discs, in half inches up to 5 in. and in inches up to 10 in., are in two drawer sections—one for round and one for oval center holes.

The chief declares his preference for manhole and handhole boiler gaskets of asbestos reinforced with fine brass wire.

The pump packing drawer contains waterproof hydraulic ring, medium soft, packing made of long fiber flax for cold water pistons, brine pumps, etc. That with the rounded corners takes care of an old pump with rods out of alinement. Here is hard black packing for the hot syrup, oil refuse and oil burner pumps.

Chided by the superintendent, the chief points out that he requires a softer packing for engine governors; that too hard a packing causes the governor to stick, just the same as will insufficient oil or glands taken up more than finger tight.

Possibly the best investment around a plant where there are both stationary and marine engines would be a good selection of sheet packings. The chief has his in rack compartments containing sheets of packing with asbestos base for steam hose gaskets, steam chests, gasoline engine igniters and manifold gaskets and for all Diesel engines he has oil-proof packing for heavy oils, joints and cylinder heads where gaskets are apt to become oil saturated and also for his oil gear cases on the machines. Sheets of 1/32, 1/16, 3/16 and ¼-in. special packing for high pressure and superheated steam joints—well adapted for air, ammonia and acid packings. Among this most complete stock of packings we have ever had to draw from are included wire inserted sheet packing for pipe flanges, gaskets for steam joints and packing against alkalies, syrups and hot water, common to the processing in this modern packing plant.

The chief explains to a field expert that his molded rubber gaskets will not serve in the packing of this hydraulic press plunger subjected to 6000 lb. pressure, for the oil on the plunger rapidly disintegrates the rubber and leather hydraulic packing rings are required.

When a chief explains why he must have specific packings for specific power problems, he should meet with the minimum of what we would term "requisition resistance." When executives grasp the idea that a com-

plete stock of packings offers an inexpensive assurance against "power grief," then our chief engineers across the continent will have more inclusive stocks in their lockers.

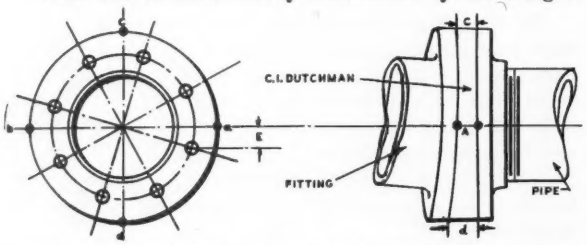
Vancouver, B. C. S. H. COOKE.

Tapered Dutchman for Joining Two Pipe Flanges

IN READING THE DECEMBER 1 issue of Power Plant Engineering, I was much interested in the article on page 1160 in which Mr. Beal describes the use of an emergency dutchman.

This calls to mind a similar case which I encountered some time ago, only in that instance the two pipes did not line up properly; that is, the faces of the two flanges were not parallel, one with the other, either on the vertical center line of the flange or on the horizontal center line.

This will be more clearly understood by referring to



DETAILS OF TAPERED DUTCHMAN FOR JOINING TWO PIPE FLANGES NOT IN PROPER ALINEMENT

the accompanying figure, which shows the pipe in end view and elevation.

The exact dimensions are not remembered by the writer, but they are represented in the figure by the letters a, b, c, d, and E.

When erected, the flange of the pipe and the flange of the fitting failed to come together as shown in the elevation of the figure.

In order to have a special tapered dutchman made in a machine shop nearby where the pipe work was being installed it was necessary to obtain the four dimensions as shown, a and b being taken in line with each other and c and d in line with each but at right angles with a and b; all four of these dimensions were different, no two of them being exactly the same.

Since one of the flanges was cast on a fitting and could not be revolved it became necessary to locate the bolt holes in relation to the points a, b, c and d in order to have the drilling of the tapered dutchman match up with the holes in the fitting flange, dimension E, as shown in the end view, was given for this purpose.

In making the "dutchman," ⅛ in. was allowed for the two gaskets, one on each side, so that the pipe work would not have to be "sprung" more than necessary when inserting the gaskets and making up the joint; and the bolt holes in the dutchman were drilled ⅛ in. larger in diameter than those in the other flanges on account of the tapered connection.

The writer furnished the machinist with a sketch of the dutchman or filling piece, giving the inside and outside diameter, diameter of bolt circle, number and size of bolt holes and the dimensions a, b, c and d, minus ⅛ in., and also dimension E, locating one bolt hole in relation to the center line on which dimensions a and b were given. When the dutchman was delivered it was fitted in place with very little trouble and made a perfectly tight joint, but, as the writer remembers, it was necessary to bend a few of the bolts slightly when making up the joint.

Emergency dutchmen such as described by Mr. Beal are sometimes made to fit just inside the bolt holes of the two flanges, to do away with the necessity of drilling them. The dutchman shown tapered in the figure of the present article could, of course, have been made this way also, in which case it would have been unnecessary to locate the bolt holes since the dutchman would not have to be drilled; the writer believes, however, that it is best, where possible, to make these filler pieces the full diameter of the other flanges.

Woodhaven, N. Y. W. F. FISCHER.

Trends In Combustion Equipment

IN THE ARTICLE written by R. C. Roe which appeared in the December 15 issue, several statements seem to me to require explanation and amplification.

In the paragraph headed "Stokers and Pulverizers," Mr. Roe states that "there seems to be a continuing tendency toward the use of pulverizers notwithstanding the fact that stoker manufacturers are constantly producing improved stokers which are capable of improved performance and which can show results approximately equal to those of pulverized fuel stations." This statement appears to be at variance with the figures published by the Department of Commerce, Bureau of Census of the United States Government.

These figures show very clearly that whereas in 1930 the sale of stokers only exceeded the sale of pulverizers by 53 per cent, in 1931 the sale of stokers exceeded the sale of pulverizers by 335 per cent.

This tendency is further borne out by figures for several years previous to 1930 but as these figures are not published by the Department of Commerce, since this department did not publish pulverized fuel figures until 1930, I am not quoting them here.

I also think that it would be extremely difficult for anyone to say that stoker figures are only approximately equal in performance to those of pulverized fuel as stated by Mr. Roe. Since it is impossible to make such a comparison, unless two stations were built having identically the same load factors, the same exit temperatures, the same heat recovery devices of various kinds, etc., so that a direct comparison could be made.

Personally, I do not know of any pulverized fuel station in the United States which has a higher boiler room efficiency than that of the Richmond Station of the Philadelphia Electric Co. This company has published figures giving the annual results as being close to 90 per cent, and this is a stoker plant.

Concerning the next paragraph of Mr. Roe's article entitled, "Air Heaters," I would like to call attention to the fact that the preheat as frequently stated for pulverized fuel plants is not the temperature of the air which enters the furnace, but it is the temperature of the air leaving the preheater. Therefore it is often thought that this temperature is higher than the actual temperatures in stoker plants.

A certain portion of the air leaving the preheater in a pulverized fuel plant is used in the mills and must be tempered. This reduces the average of the air temperature entering the furnace.

Philadelphia, Pa. E. J. HUSTED.

Plant Operation Problems

Motor Operation Problems

FOR THE MOST part, motors just run and the routine of maintenance covers checking of oiling, bearing wear, clearances, belt condition, heating and commutator action. Provision for regular attention to these points is essential in every plant.

Often, however, problems arise involving special conditions and irregularities. For these, interchange of opinion and experience are of great value. In the issues of The Motorizer sent out by The Lincoln Electric Co., Cleveland, Ohio, are found problems sent in for solution, which should bring out helpful discussion. Herewith are some of them which it is believed will interest readers of Power Plant Engineering. Your comment is invited.

In case a wound-rotor motor whose collector rings have been removed and rotor terminals securely tied together fails occasionally to start when proper voltage is applied to the terminals, what is the cause and what the remedy?

What loss in efficiency would result from connecting 220-v., 2-phase motors of 2 to 20 hp. for 220-v., 3-phase?

What form of guard is good for preventing oil and grease being thrown from a chain and sprocket onto the motor?

In a 3-phase motor, line voltage is balanced but currents are not in the three phases. Resistance tests at 20 deg. C. show: For phase 1-2, 0.82 ohms; for 2-3, 1.24 ohms; for 3-1, 1.24 ohms. Where is the trouble?

For average load 5.5 hp. and maximum load over a 1½ to 2-hr. period of 6.8 hp., will a 5-hp. motor be satisfactory?

Load on a 20-hp. slip-ring motor with speed varied, runs from 5 hp. at high speed to 25 hp. at low speed. At heavy load, the speed is too irregular. Can this be remedied by a different controller?

For individual drive on isolated machines, what is the best type of induction motor for variable speed?

If you have had experience which will help, let's pass it along. Published replies will be paid for.

Manhole Gasket Replacement

YOUR "Problems Encountered by Boiler Attendant," which appear on page 1119 of the November 15, 1931 issue of Power Plant Engineering, interests me. If I may, I would like to add something to the answer that is made to question 3, "State how you would put the manhole plates back in the boiler. Give details." The following detail was practiced years ago, both in stationary and marine service, and it would seem that it is applicable in present times as well.

The face of the manhole plate against which the gasket lay should be given a coat of white lead, so that the gasket will firmly stick to the plate when the plate is removed from the boiler for cleaning or any other purpose, and the surface of the gasket that contacts the flange on the boiler shell should be coated with a mixture of graphite and cylinder oil so that the gasket will not tend to stick to the flange on the shell upon removal of the plate. The gasket will be better preserved for a longer period by sticking to the plate than otherwise. When replacing the plate, all that is necessary is again to coat the surface that contacts the flange, with the graphite and cylinder oil paste. By doing this, I have known boiler plate gaskets to last and keep in good condition for long periods. Even with metal gaskets this procedure is permissible, although it is particularly adaptable to the rubber type of gasket.

Brooklyn, N. Y. CHARLES J. MASON

Boiler Water Questions

WHY IS it best to carry the water at a constant level in the boiler?

2. Mention several ways in which a boiler may be damaged by heating or cooling it too rapidly.

3. What should be done if you find some pitted places inside the shell of a boiler?

4. If you have three gages of water in the boiler, but the fusible plug should melt out, what is probably the reason?

5. When the water is at the second gage, how high should it be over the top row of tubes in a horizontal boiler? R. B.

A. When a boiler is used for heating purposes and steams easily, it does not make much difference whether it is fed continuously or not, but a power boiler should be fed continuously otherwise the water level may vary dangerously. Aside from the ill effects of uneven contraction and expansion and the danger of having the water supply cut off while the feed valve is closed, feedwater must be introduced at a greater rate than would be necessary if fed continuously. The feedwater entering the boiler when the volume has been reduced, as at the time for "pumping up," has a cooling effect on the water in the boiler. This invariably requires heavy firing to maintain the steam pressure. The result is a variable rate of combustion with more coal burned than would have been necessary had the water been kept at a constant level.

2. The seams may be loosened by stretching of the rivets. The ends of the tubes may become loosened. The braces may be stretched or distorted. Grooving or channelling may also occur.

3. The A.S.M.E. code states: Where pits occur closely grouped or alined and are deep enough to affect the strength of the material, the affected area shall be removed and repaired as directed by an authorized inspector. Isolated pits not affecting the strength of the material may be kept from becoming serious by cleaning the pit carefully and electrically welding, or by applying some form of protective coating.

4. Assuming that you have three gages of water in the boiler, as you state, and the fusible plug melts out, the reason probably is that the plug is substandard in design. It probably does not extend 1 in. into the water and therefore does not have sufficient cooling surface; it then limes up and prevents sufficient cooling and as a result will soon melt out.

5. When the water is at the second gage cock, the level should be from 5 to 7 in. above the top row of tubes depending on the size of the boiler.

Electrical Engineers Present Varied Program at Winter Meeting in New York

ENGINEERING DEVELOPMENTS in many specialized fields of the electrical art were discussed during the Winter Convention of the American Institute of Electrical Engineers at New York, January 25 to 29. With a registered attendance of about 1400, among whom were many of the most notable electrical engineers and research men in the country, the meetings were not only a source of interest but also of inspiration to all those privileged to attend.

Today the electrical art is a complex one, so much so, indeed, that it is not given to any one man, to have a grasp upon all the specialized branches into which it is divided.

Because of this the papers presented at such a meeting as the one held last month are grouped and presented as a number of symposiums on different topics. The general technical program, in this case, included symposiums on the following subjects: Protective Devices; Instruments and Measurements; Distribution Circuit Lighting Protection; General Circuit Theory; Power Station Auxiliary Drive; System Stability; Research, Electrical Machinery; Electrochemistry; Transportation; Communication and Electric Welding.

To the power engineer, the groups on Protective Devices, Lighting Protection, Station Auxiliary Drive and System Stability were of greatest interest. The session dealing with protective devices was the first thing on the weeks program. This included papers on the theory of oil blast circuit breakers, circuit interruptions and on recent developments in arc rupturing devices. The question of arc rupturing particularly as applied in circuit breaker design seems to have divided itself into two viewpoints, one led more or less by the engineers of the Westinghouse Company, which considers arc rupture from the purely electronic standpoint and the other, that held by engineers of the General Electric Co., which takes a more practical, if less academic viewpoint. As a consequence of these different views two forms of circuit breakers have been developed, one the oil blast breaker and the other the device breaker.

Lightning Protection Still Unsolved

Lightning continues to be the great unknown variable to the electrical engineer concerned with the transmission and distribution of electrical power. To those engaged in this field, the session on Tuesday morning on Distribution Circuit Lightning protection was of particular interest. The opening paper in this group entitled "Interconnection of Primary Lightning Arrester Ground and the Grounded Neutral of the Secondary Mains," concerned a coöperative investigation by the Utilities Research Commission of Chicago and the Engineering Experiment Station at Purdue University, into this question of surge protection of distribution circuits. Among other valuable conclusions reached by the investigators was that the interconnections of the primary lightning arrester ground to the grounded method of the secondary main of a pole type distribution transformer effects a considerable reduction in voltages at the transformer and imposes no extra hazard upon the consumers' wiring. This same subject was also discussed in a paper by K. B. McEachron and L. Saxon and again in still another paper by A. M. Opsahl, A. S. Brookes and R. N. Southgate. In all these papers and in the general discussion of them that followed, it seemed to be the consensus of opinion that the new methods of connecting transformers and lightning arresters provided a great deal more protection than is had with the older methods. Papers on lightning protection of 4000-v. circuits and distribution transformers were also presented by Mr. Roper of the Commonwealth Edison Co. Messrs. Haines and Corney of the Edison Electric Illuminating Co. of Boston and by Messrs. Dambly, Ekvall and Phelps of the Philadelphia Electric Co.

Steam and Electric Auxiliary Drive

While the subject has been discussed innumerable times before, the papers on Tuesday afternoon on Auxiliary Drive for Steam Power Stations were interesting because they presented a review of recent views on the subject. The papers were two in number, one "Steam Driven Auxiliaries of Power Plants" by W. Pool Dryer of Stone and Webster, Inc. and the other "Electrically Driven Auxiliaries for Steam Plants" by L. W. Smith of Sargent and Lundy, Inc. These two papers representing different and somewhat opposing points of view, were prefaced by a short introductory discussion by F. H. Hollister on the general subject of Auxiliary Drive.

Among those discussing these papers were A. H. Kehoe of the New York Edison Co., Irving Moultrop of the Boston Edison and Mr. Summerhays of the General Electric Co. Mr. Kehoe's discussion was a written presentation giving the experiences of the New York Edison Co. with both steam and electrically driven auxiliaries. In general his discussion seemed to favor the electrical drive although it was apparent that no hard and fast rules could be drawn.

In the operation of large systems, system stability continues to be a problem although many of the earlier difficulties have been solved. This question was the topic on Wednesday afternoon when two series of papers were presented, one on the determination of short circuits on power systems and the other on the electrical stability of certain large systems. Most interesting perhaps was a paper by R. A. Hentz and J. W. Jones, both of the engineering department of the Philadelphia Electric Co., on the stability of the Conowingo Hydroelectric Station. It gave a record of the operating experience during four years of service.

John Fritz and Edison Medals Presented

Of great general interest was the program on Wednesday evening when both the John Fritz and Edison Medals were presented in the engineering auditorium. The Edison medal was presented to Dr. E. W. Rice, Jr., for his contribution to the development of electrical systems and apparatus and his encouragement of scientific research in industry. The John Fritz medal was presented to Dr. Michael Pupin for his accomplishments as a leading scientist, engineer and author and as the inventor of the timing of oscillating circuits and the loading of telephone circuits. It was unfortunate that Dr. Elihu Thomson, who was to have delivered the Edison Medal address, could not be present but his address was read by Dugald C. Jackson, Chairman of the Edison Medal Committee.

New Equipment

Polyphase Capacitor Motor

USUALLY capacitors are applied to polyphase induction motors by connecting them across the motor terminals, producing a high power factor in the power line but not affecting the characteristics or the power factor in the motor proper. C. W. Noel, of The Ideal Electric & Mfg. Co., Mansfield, Ohio, has invented a method of applying capacitors to polyphase induction motors which causes the condenser reactive current to flow through the windings of the motor, so that the motor operates at practically unity power factor at all loads.

Noel polyphase capacitor motors are made to give 80 per cent power factor, leading at full load and leading power factors up to 15 per cent at no load, so that one of these motors will correct to near 100 per cent the power factor of two ordinary induction motors of similar size. Only one of every three motors in a plant need be of this type to give a plant power factor of unity.

All the advantages of the squirrel cage induction motor are retained in addition to unity or 80-per-cent-leading power factor.

Capacitors used are oil-filled, oil-impregnated and hermetically sealed type with individually fused section, assembled in steel cases with conduit connections for mounting on the wall or any convenient location.

Noel motor is also made as a slip-ring, variable-speed induction motor which will retain its high power factor down to even 50 per cent of standard rated speed. It is built in various types to meet all starting torque and inrush classifications including across-the-line starting in all sizes and speeds up to 200 hp.

Vertical Transmission, Enclosed Design

THIS NEW UNIT, incorporating the standard internal operating parts of the Reeves transmission is adapted for certain standard equipment installations and for installations requiring small floor space. It is enclosed in a tight cast-iron case with side cover easily removed by means of four cap screws for inspection or minor adjustments. U-shaped recesses in the main section of the case permit removal of operating parts entire.

Without removal of the cover section, radial, shaft and thrust

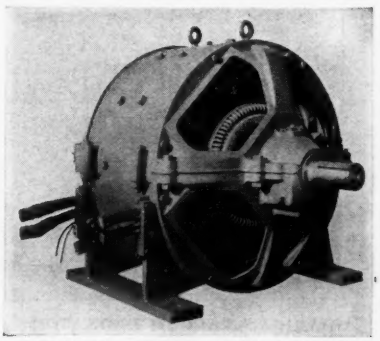
REEVES VERTICAL VARIABLE SPEED TRANSMISSION

bearings are lubricated through eight force-feed fittings located in two exterior panels with rigid copper tubes to the four radial shaft bearings and flexible copper tubes to the four thrust bearings. Holes are drilled completely through the shafts, with force-feed fittings inserted in each end. Outlet holes connect the channels with the bearing surfaces of the shafts and with the bores of the disc hubs, so that spiral lubrication grooves in those hubs will be filled. Each transmission leaves the factory with all bearings and connecting tubes thoroughly packed with high-grade lubricant, further lubrication being necessary only once every 30 or 45 days, depending upon the type of service.

This vertical transmission, made by Reeves Pulley Co., Columbus, Ind., may be equipped with electric remote, electric automatic or mechanical automatic controls, also with motors, motor bases and other accessories for varying requirements of speed control.

Larger Reliance Direct-Current Motors

MOTORS of its Type T Direct-current Line have been announced by the Reliance Electric & Engineering Co., Cleveland, Ohio, in sizes from 100 hp. at 800 r.p.m. to 350 hp. at 1200 r.p.m. In these motors a rolled-steel split-frame construction is used, with feet and supporting members of heavy bar steel



RELIANCE STEEL FRAME MOTOR

welded to the frame. Brackets and sleeve bearings are of split design.

Brushholders, combining the advantages of the reaction-type with those of the box-type, keep the brushes always at proper tension. Leads are brought through both ends of the frame and held in place by wooden cleats, hence no terminal board is used.

These motors may be supplied for constant-speed or for adjustable-speed service with a range of 2 to 1 or 3 to 1.

Deoxater Oil Purifier

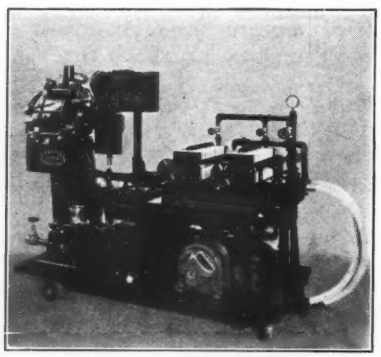
FOR PURIFYING transformer and circuit breaker oil, centrifugally and under a high vacuum, The Sharples Specialty Co. of Philadelphia has introduced a new type purifier under the registered trade name of Deoxator. This not only removes free air from the oil but also removes 90 per cent of the oxygen in solution and any dissolved moisture. The centrifuge bowl is still used to remove free water and sludge,

while the vacuum removes dissolved moisture and oxygen in solution. Unless the free water is removed first by the centrifuge bowl, the vacuum efficiency is destroyed by the surplus water vapor.

Effective use for the Deoxator is in filling and drying out new equipment, filling Inertaire type transformers, centrifugal transformer oil to prevent the introduction of air into the transformer, purifying oil for oil-filled cables and subway type transformers.

Weight by a Light Beam

ACCURATE weighing of the steady flow of material passing on a conveyor belt and recording the belt loading on a chart is the latest job undertaken by electric eye and ingenious electric brain.



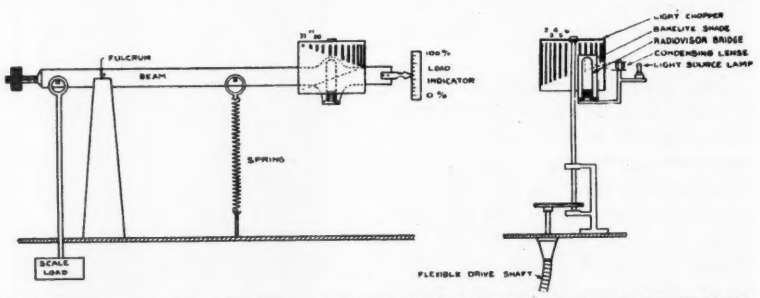
SHARPLES VACUUM DEOXATOR

To obtain the weight of a continuous flow of material, it is necessary to use the size of the stream and the speed at which it moves. Conveyor speed may be constant but the size of the stream may range from zero to the full capacity of the conveyor, consequently, any variation of load must be instantaneously noted at the controller if true integration of weight is to be obtained.

At the point where the continuous stream of material is to be weighed, a short section of belt is installed, so mounted that its weight actuates the weight checking equipment placed directly above, causing the fulcrumed beam to swing over the scale of the load indicator at the far or free end. To keep tally of the continuous procession of varying weights, the electric eye gets to work.

Close to the free end of the swinging beam is mounted a cross arm carrying a Burgess Radiovisor Bridge or simplified form of light-sensitive cell and a light source lamp. These members are so mounted that one is outside while the other is inside a revolving light-chopper cylinder, driven in step with the speed of the belt and having 32 parallel longitudinal slots of varying lengths which serve to interrupt the passage of the beam of light between light source and bridge. The first slot has height equal to the distance traveled by the scale beam from zero to full load, each succeeding slot being shortened by an equal amount at the bottom.

Mounted in a housing provided with a window directly opposite the sensitive plate is the bridge or cell. The condensing lens of the light source is adjusted to concentrate an intense beam of light through the window on the light-sensitive plate but the wall of the rotating chopper cylinder comes between, allowing the light beam to pass only when a slot is in line. Each admission of light reaching the bridge sets up an electrical impulse, which in turn drives the mechanism of the integrator tally and the time chart recorder.



LIGHT BEAM INTEGRATOR PRINCIPLE FOR WEIGHING BELT CONVEYOR LOADS

With no load on the belt, the free end of the beam is down, with the focused point of light just below the bottom of slot 1 of the chopper cylinder, hence no impulses result. As load is placed on the belt, the beam swings upward proportionately, so that more and more slots admit light to cause a corresponding number of impulses, always proportional to the load, at full load giving 32 impulses per revolution of the chopper cylinder.

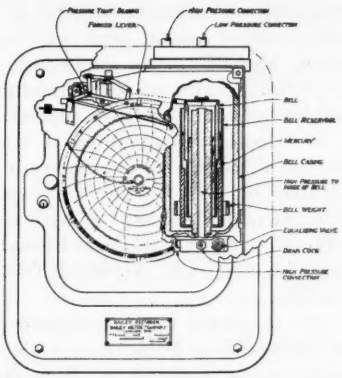
Balancing the scale is simple, a test weight being provided which, when hung on the beam represents exactly half load. A switch serves to cut out the integrator and throw in a small lamp which flashes at each impulse, a change gear being provided, which slows up the revolutions of the chopper cylinder so that the flashes may be counted. At no load, if the machine is properly balanced, there should be 16 flashes for each complete cycle, and the scale is adjusted with a balance ball until 16 flashes are obtained.

Electrical impulses are amplified by means of a two-stage amplifier designed and built by the engineering staff of the Burgess Battery Co. of New York City. This amplifier output operates a Burgess vacuum contact relay capable of operating one or more integrators or counters, which may be located at any distance from the scale. Low-voltage direct current, rectified from stepped down alternating, operates, in accordance with the makes and breaks of the vacuum contact relay, the electro-magnetic counter-integrator and scale chart.

This telepoise, as the weighing and recording mechanism is termed by its designer, E. J. White of the staff of John Chatillon & Sons, is finding many applications where bulky materials must be weighed while in motion, giving a radically new method of weighing and recording materials on a moving conveyor belt.

Boiler Water Level Recorder

ILLUSTRATED herewith is the Bailey Water Level Recorder which operates on the difference in level obtained by making two connections to the water column or boiler drum; one connection is made to the water space and the other to the steam space, where a constant water head is maintained in the connection by means of a steam-condensing radiator and a reservoir. The variable head or water space connection is applied over a mercury-sealed bell



BAILEY WATER LEVEL RECORDER

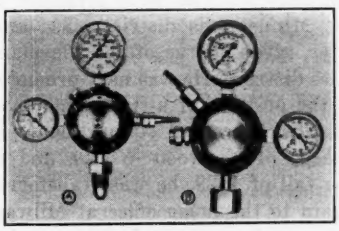
and the constant head connection is applied to the inside of this bell.

As the boiler water level rises or falls, the mercury-sealed bell falls or rises, this motion being transmitted to the recording pen by a forked lever and a spindle which turns in pressure tight bearings. A reversing linkage is employed between the spindle and recording pen so that the pen moves upward as the water in the boiler drum rises and moves downward as the water level drops.

This recorder may be incorporated with a feedwater flow meter to record the two related factors on one chart for easy comparison, also remote indicators or recorders, operating from the main recorder can be plated at other points, if desired. Types and combinations are available in all pressure standards up to 1800 lb. per sq. in.

Purox Regulator

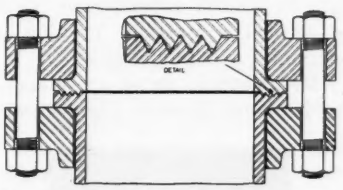
To REGULATE volumes of oxygen and acetylene and maintain a neutral flame at the blowpipe tip for cutting or welding, a new series of Purox regulators has recently been introduced by the Linde Air Products Co.; Nos. 33 and 34 are for acetylene, Nos. 13 to 24 for oxygen. Features of the design are a self-alining valve of the nozzle and yoke type, valve seat replaceable without disturbing pressure adjusting parts, corrosion resisting diaphrams, rupturing disc safety release for abnormal oxygen pressure and heavy pressure gages with plate glass crystals. The acetylene regulators, A are painted red, while oxygen regulators, B are green for identification.



A. ACETYLENE REGULATOR
B. OXYGEN WELDING REGULATOR

High-Pressure Joint

IMPROVED Vanstone joint manufactured by the American Power Piping Corporation, of St. Louis, Mo., has several new features for exceedingly high pressures and super-heat. It requires no grinding nor



SPECIAL VANSTONE JOINT CONSTRUCTION

gasket and can be taken apart and put together without causing leakage. The special feature is the concentric V rings in flanged pipe ends which mesh and spring to a tight seating.

Death of Wm. D. Pomeroy

WILLIAM D. POMEROY, general manager, vice-president and director of Goulds Pumps, Inc., Seneca Falls, N. Y., died on Wednesday, January 6, 1932. He had been in ill health for more than a year, having been a patient for the past several months at Clifton Springs Sanitarium.

Mr. Pomeroy was born in Utica, where he received his early education, graduating in 1895 from Cornell University in electrical engineering. At Cornell, he was honored by membership in Sigma Phi fraternity.

From 1901 to 1907, he was employed with the Bullock Electric Co. of Cincinnati, a subsidiary of the Allis-Chalmers Manufacturing Co. With that company, he advanced from draftsman to works manager.

In 1907, Mr. Pomeroy came to Seneca Falls as works manager of The Goulds Manufacturing Co. In 1915, he was made general manager and for several years past he has occupied that position as well as having been elected a vice-president and director of the company.

A year ago, Mr. Pomeroy was awarded the Melville Medal by the A.S.M.E. for a paper, which he prepared jointly with Prof. Herman Diederichs of Cornell University, on The Occurrence and Elimination of Surges or Oscillating Pressures in Discharge Lines from Reciprocating Pumps.

W. S. Lee New President of American Engineering Council

WILLIAM S. LEE of Charlotte, N. C., past president of the American Institute of Electrical Engineers, was elected president of the American Engineering Council at the annual meeting of the Council in Washington, January 14-16. Mr Lee, who succeeds Carl E. Grunsky of San Francisco, will hold office for two years.

L. B. Stillwell and General Richard C. Marshall, Jr., of New York were chosen vice presidents. Farley Osgood of New York was named treasurer to succeed Dr. Harrison E. Howe of Washington.

Mr. Lee, pioneer in high tension hydroelectric power development and transmission in the United States and Canada, is president of the W. S. Lee Engineering Corp., vice chairman of the Duke Endowment, and consulting engineer of many public utility and industrial enterprises.

He was born in Lancaster, S. C., in 1872. He received the degree of civil engineer from the Military College of South Carolina and the honorary degree of doctor of science from Davidson College, North Carolina. He is president and chief engineer of the Piedmont and Northern Railway Co., and vice president and chief engineer of the Duke Power Co. the Wateree Power Co., the Western Carolina Power Co. and the Catawba Mfg. and Electric Co. He is a director of the American Cyanamid Co. and of the Duke Power Co.

Companies of which he is consulting engineer include Aluminum Co. of America, American Cyanamid Co., Beauharnois Light, Heat & Power Co., Hydroelectric Power Commission of Ontario, Buffalo-Niagara & Eastern Power Co. and International Paper Co.

Mr. Lee is a fellow of the American Institute of Electrical Engineers, and a member of the American Electrochemical Society, Ameri-

can Society of Mechanical Engineers, American Society of Civil Engineers and the Engineering Institute of Canada.

Matthew S. Sloan Resigns from N. Y. Edison Co.

MATTHEW S. SLOAN has resigned as president of The New York Edison Co. and its affiliated electric companies, and as trustee of the Consolidated Gas Company and director of companies in the Consolidated Gas group, effective immediately. "I have business plans for the future which I am not at liberty to discuss now," said Mr. Sloan in announcing his resignation.

MATTHEW S. SLOAN

Mr. Sloan was elected president of The New York Edison Co. and other electric companies in the Consolidated Gas group in September and October, 1928, following purchase of stock control of the Brooklyn Edison Company by Consolidated. He had been president of the Brooklyn Edison Co. for nine years, creating a record as a brilliant and sound utility operator and a position of leadership in the electrical industry. Under his presidency the revenues of the Brooklyn Co. rose from about $8,500,000 a year to about $48,000,000, at present, in spite of several voluntary rate reductions. One of the things of which he was proudest was the new Hudson Avenue generating station, designed and its erection supervised by company engineers under his leadership.

Placed in command of the group of electric companies, Mr. Sloan made striking changes in their policies and operating methods. Almost immediately he announced a voluntary rate reduction and rate studies looking to the adoption of a uniform promotional rate structure for the companies in New York City. This culminated in the new rates approved by the Public Service Commission last June which the Commission estimated would reduce bills about $5,500,000 annually.

Engineering policies were reorganized to promote efficiency and economy. He developed in Manhattan, as he had done in Brooklyn, a modern alternating current network distribution system in the interest of economy and efficiency. He began a fight to abolish submetering, which he termed a parasite preying on companies and public alike.

Mr. Sloan is an ex-president of the National Electric Light Association, the Association of Edison Illuminating Companies and the Empire State Gas and Electric Association. In his own companies and for the electric industry at large he has been an outspoken advocate of obtaining public goodwill by earning it through good service and rates as low as are compatible with sound business standards.

CLARENCE E. SEARLE

C. E. Searle Resigns from Allis-Chalmers

CLARENCE E. SEARLE, general representative of the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has resigned to accept the vice-presidency of an eastern firm; his resignation became effective January 31. General Falk, president, in announcing Mr. Searle's resignation, states, "It is with great regret that I am obliged to announce Mr. Searle's resignation. He has proved a capable executive, a faithful and conscientious worker and has endeared himself to the organization, all of whom join me in extending best wishes for his future success." L. W. Grothaus, appointed to succeed C. F. Searle as general representative of Allis-Chalmers, became affiliated with the company with the acquisition of the Bullock Electric Manufacturing Co., Norwood, Ohio, in 1904.

Mr. Grothaus was transferred to the home office at Milwaukee in 1908, which made possible a thorough knowledge of all of the products manufactured by the company. In 1913, he became sales engineer in the Milwaukee district under the leadership of C. E. Searle, and continued in that capacity until 1917, when his services were loaned to the Government as a member of the staff of the War Industries Board. Due to his knowledge of the electrical and power generating machinery, he was assigned, among other duties, the responsibility of allocating the capacity of the steam turbine industry to the war needs of the Army, Navy, Emergency Fleet Corporation, etc. He remained a member of the War Industries Board until December 31, 1918; returning to the company, he was made manager of the Minneapolis district office and, later, given charge of the Cleveland sales district. He was next promoted to the position of assistant manager of the electrical department in charge of Norwood Works, and in the fall of 1929, he was transferred again to the home office at Milwaukee, to take up new duties as assistant manager of the electrical department.

L. W. GROTHAUS

News from the Field

ACCORDING TO a recent announcement by Starkweather & Broadhurst, Inc., engineers and contractors, Boston, Mass., the new Boston Post Office has ordered four cross-drum Murray Iron Works boilers, each of 3000 sq. ft. heating surface, to be stoker fired and designed for 160 lb. pressure. These units will supply steam for the building.

BAILEY METER CO. announces the appointment of W. J. Reeder as manager of its St. Louis branch office to fill the vacancy from the death of C. J. Prendergast, which resulted from injuries received in a building collapse at Paoli, Indiana, a short time ago. For the past 7 yr. Mr. Reeder has been with the Chicago office of the company in the solution of metering, controlling and regulating problems. He will be assisted by J. R. Buss, who has been in the St. Louis district for the past 4 yr., their headquarters being room 127, 457 North Kingshighway, Telephone Delmar 4770.

DAMPNEY CO. OF AMERICA, Hyde Park, Boston, Mass., announces that Clarence J. Hunter, formerly Philadelphia district manager and then general sales manager, has been elected vice president and will be in charge of sales.

AMERICAN KRON SCALE CO. has recently been reorganized under the name of The Kron Co. The reorganization was decided upon to provide additional capital for use in broadening the lines of manufacture and increasing the activities of the company. The plant has been moved from its old location in New York City to 1720 Fairfield Ave., Bridgeport, Conn., where larger and more adaptable space is available. Richard F. Straw, associated with the Wright Manufacturing Co. since the war, has resigned his position as sales manager to become president of the new organization. The other officers are F. W. De Foe, vice president, and H. C. Stevenson, secretary and treasurer. The board of directors consists of Ernst Ohnell, chairman; T. A. Yawkey, F. W. De Foe, Richard F. Straw and H. C. Stevenson. George A. Nichols, New York manager of the Wright Manufacturing Co., has also resigned to become associated with the new company in an executive capacity.

MERCON REGULATOR CO., Chicago, Ill., announces the appointment of R. E. Chase & Co. of Tacoma, Wash., as its representative for the states of Washington, Oregon, and Idaho.

K. M. IRWIN, who has been mechanical engineer of The U. G. I. Company since January, 1927, has been appointed assistant to the vice-president in charge of mechanical engineering, Philadelphia Electric Company.

Mr. Irwin entered U. G. I. employ in February, 1919, as an assistant to the electrical engineer, and held that position until he was appointed mechanical engineer. Prior to that he had been employed by B. F. Sturtevant Co., Hyde Park, Mass.; Stone & Webster, Boston; Perry Barker, consulting engineer, Boston, and U. S. Navy, Philadelphia. In these connections his experience included fan, turbine, and economizer design and testing, power station operation, fuel testing, and inspection of engineering material.

He is a graduate of the Sheffield Scientific School, Yale University, in mechanical engineering, and Phillips Academy, Andover, Mass.

Mr. Irwin is a director of The Engineers Club of Philadelphia, and has been active for years in the American Society of Mechanical Engineers, having been chairman of the Philadelphia Section in 1930-'31. He is at present a member of the Society's Executive Committee, Fuels Division, and chairman of the Research Committee on Fluxing Boiler Slags. For nine years he was a member of the Prime Movers Committee, National Electric Light Association, and was chairman of the Prime Movers Committee, Pennsylvania Electric Association in 1923-'24.

JAMES P. FERGUSON has been appointed assistant general manager of sales of the Reading-Pratt & Cady Co., Bridgeport, Conn. Mr. Ferguson has been associated with the Reading-Pratt & Cady Co. for the past 10 yr. as sales engineer.

BADENHAUSEN CORP. of Cornwells Heights, Pa., announces the election of the following officials and board of directors: President and director, F. H. Daniels; vice-president and director, James W. Armour; secretary-treasurer and director, William N. Way; assistant treasurer and director, E. G. Stoler; director, David K. Beach. John Phillips Badenhausen has severed his official connection with the corporation.

For the Engineer's Library

1931 A.S.T.M. PROCEEDINGS. Published by the American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa., in two parts. Part I, 1070 pages; Part II, 998 pages; 6 by 9 in.; price, each part, $5.50 paper; $6.00 cloth and $7.00 half leather.

Part I contains the annual reports of 42 standing and research committees together with the papers and standards which accompanied the reports. There are 74 tentative standards published for the first time in 1931 included in this volume.

Part I contains the technical papers which were given at the annual meeting of the society in 1931. These include papers on fatigue, testing and corrosion of metals; a symposium on malleable iron castings; tests on concretes and fire clays; weathering of masonry; testing of rubber; paints and protective coatings and a symposium on the economic significance of specifications for materials. This volume also contains the Edgar Marburg Lecture delivered last year by A. Nadai, on the Phenomenon of Slip in Plastic Materials.

Each volume has a detailed subject index and an author index.

COMBUSTION ENGINEERING CORP., 200 Madison Ave., New York, has just issued a catalog describing the C-E VW Type boiler, of the bent-tube type designed especially for plants having limited space and where the head room is low. This boiler is available in sizes ranging from 1215 sq. ft. to 5328 sq. ft. of heating surface. It has large boiler drums, large steam liberating surface, and filter baffles which stagger the flow gases around the tubes, thereby promoting heat transfer with but little effect on the draft loss.

PROPERTIES and advantages of a new alloy steel, containing chromium and vanadium, which has been developed by the Union Carbide and Carbon Research Laboratories, Inc., are given in a booklet issued by Electro Metallurgical Co., 30 E. 42nd St., New York. This Bulletin No. CV-1 explains the effect of vanadium, some 0.3 per cent in excess of that required to form vanadium carbide so as to have some in unbound form, on the nitriding of steel for surface hardening. The result is a tough, easily machined alloy which can be rapidly surface hardened at relatively low temperature, ammonia nitriding being recommended where a heavy case is needed, with duplex cyanide treatment giving satisfaction for a thin hard case.

MASON REGULATOR CO., Boston, Mass., is sending out a 16-p. bulletin describing a new line of pressure control instruments for process industries, with great precision in control and simplified adjustment. The Mason Rota-Port Synchronizer enables instruments to be synchronized to the speed of any process, while a new principle in design gives the straight line function, so that, for every increment of movement of the control element, there is a definite and uniform increment of movement of the diaphragm control valve.

CLASS D Single-seat, pressure reducing and regulating valve is completely described in Bulletin No. 950 recently issued by A. W. Cash Co., P. O. Box 135, Decatur, Ill. These valves are now furnished with working units of Nitralloy, details of which are described in the bulletin.

TYPE H STIRLING BOILER, a three-drum three-pass, water tube boiler designed for low headroom and small floor space, is completely described in Bulletin G-8, a well illustrated, 32-page bulletin just published by the Babcock & Wilcox Co., 85 Liberty St., New York. This boiler is made in four classes with effective heating surface ranging upward from 714 sq. ft. to 5071 sq. ft. Boilers are designed to be set singly or in battery and setting heights can be varied to suit any condition of firing. Details of drums, tubes, baffles and method of support are given, with drawings of typical settings and applications to various industries.

MCCORD UNIT HEATERS, their design, details of construction and method of application are discussed in a recent bulletin of the McCord Radiator & Mfg. Co., Detroit, Mich.

Power Plant Construction News

Ark., Fort Smith—Mississippi Valley Power Co., Fort Smith, plans extensions and improvements in transmission and distributing lines in vicinity of Port Smith, Van Buren, Ratcliff, Lamar and Charleston; additional equipment will also be installed in a number of substations in districts noted.

Calif., Los Angeles—Willard Storage Battery Co., 5700 East Ninth Street, plans installation of electric power equipment in new plant units for lead oxide and acid service, respectively, reported to cost close to $100,000. Company headquarters are at East 131st Street and St. Clair Avenue, Cleveland, Ohio.

Calif., Ryde—Libby, McNeil & Libby, Ryde, plans installation of electric power equipment in connection with proposed rebuilding of portion of local food products packing plant, recently destroyed by fire with loss over $300,000. Headquarters are at the Union Stock Yards, Chicago, Ill.

Colo, Colorado Springs—City Council is arranging a fund of about $200,000, for extensions and betterments in municipal electric power plant, including installation of new turbine unit and accessories. City engineering department will be in charge.

Colo., Pueblo—Southern Colorado Power Co. plans extensions and improvements in transmission lines and power substations at Pueblo, Fowler, La.; Junta, Cripple Creek and vicinity, estimated to cost about $150,000.

Iowa, Cedar Rapids—Three-Minute Cereals Co., Cedar Rapids, plans installation of electric power equipment in proposed new plant for manufacture of breakfast foods at Mexico City, Mex., entire project reported to cost over $100,000. Frank G. Pemberton is president.

Iowa, Grand Junction—At a special election, citizens have authorized a bond issue of $85,000, for a municipal electric lighting plant, recently referred to in these columns. Plans will be prepared at once. J. H. Watts is city clerk.

Iowa, Iowa City—Iowa City Light & Power Co. is said to be arranging a fund of about $60,000, for extensions and improvements in power plant and system during the present year. C. H. Myers is general manager.

Ky., Louisville—P. Bannon Pipe Co., Magnolia Avenue, is said to be planning installation of electric power equipment in connection with proposed rebuilding of sewer pipe manufacturing plant, recently partially destroyed by fire with loss reported close to $40,000.

La., New Orleans—Howard Flint Ink Co., 2545 Scotten Avenue, Detroit, Mich., manufacturer of printing inks, plans installation of electric power equipment in proposed new branch plant on South Jefferson Davis Parkway, New Orleans, entire project reported to cost about $55,000.

Mass., West Dudley—West Dudley Paper Co., West Dudley, plans installation of electric power equipment, including turbine unit, in connection with proposed rebuilding of portion of mill, recently destroyed by fire with loss estimated in excess of $100,000.

Mass., Worcester—Reed & Prince Manufacturing Co. will build a Diesel engine plant at their factory on Cambridge Street, to cost $100,000. Francis J. Sill, Consulting Engineer, Westboro, Mass., is drawing plans.

Mich., Kalamazoo—Board of Public Works, Kalamazoo, plans installation of pumping machinery and auxiliary equipment, in connection with a waterworks expansion and improvement program. Work is scheduled to begin in March, and is estimated to cost about $300,000. E. C. Rutz is city engineer.

Mo., Kansas City—Kansas City Power & Light Co., Fourteenth Street, has plans under way for a power substation on Myrtle Avenue, reported to cost close to $60,000, with equipment. Company will proceed with superstructure for similar one-story substation, 70 x 180 ft., on Nicholson Avenue, to cost $50,000.

Mo., St. Louis—Board of Public Service, City Hall, plans construction of a boiler plant and mechanical laundry at proposed new city hospital at Goode Street and Kennerly Avenue, entire project to cost over $300,000. L. R. Bowen, City Hall, is city engineer.

Mont., Butte—Montana Power Co., Butte, is arranging a fund of about $2,000,000, for extensions and improvements in power plants and system during the present year. Company engineering department will be in charge.

N. J., Dover—New Jersey Power & Light Co., Dover, has made application to the State Public Utilities Commission for permission to issue bonds in amount of $848,000, portion of fund to be used for extensions and improvements in plant and system during 1932.

N. J., Trenton—Young's Rubber Corporation of New Jersey, Enterprise Avenue, near Plum Street, contemplates installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire with loss estimated at close to $100,000.

N. Y., Brooklyn—Scandore Paper Box Co., 169 Franklin Avenue, plans installation of electric power equipment in new plant at 31-43 Steuben Street, where seven-story factory, 100 x 160 ft., has been purchased. Entire project will cost over $300,000.

Ohio, Cleveland—Ohio Chemical & Mfg. Co., Marquette Street, has plans under way for extensions and improvements in power house, reported to cost close to $30,000, with equipment. Mayer & Valentine, Plymouth Building, are engineers

Okla., Commerce—Eagle-Picher Mining & Smelting Co., Picher, Okla., an interest of the Eagle-Picher Lead Co., 124 North LaSalle Street, Chicago, Ill., will build its proposed new lead and zinc concentrating and refining plant, recently referred to in these columns, on site near Commerce. Electric power equipment, pumping machinery, etc., will be installed. Entire project will cost over $400,000, instead of smaller amount previously noted.

Ore., Klamath Falls—California-Oregon Power Co., Medford, Ore., plans extensions and improvements in power substation in vicinity of Tule Lake, near Klamath Falls, including new transmission lines, reported to cost about $40,000.

Pa., Philadelphia—E. I. du Pont de Nemours & Co., Thirty-fourth Street and Grays Ferry Avenue, plans installation of electric power equipment in new five-story addition to local plant, to be used for paint manufacture, estimated to cost over $400,000. Superstructure will soon begin. Headquarters are at Wilmington, Del.

S. C., Charleston—South Carolina Power Co., Charleston, is said to be arranging a fund of about $1,300,000, for operating service during 1932, a portion of appropriation to be used for extensions and improvements in power plants and system.

S. D., Yankton—State Board of Charities and Corrections, Pierre, S. D., is said to be planning early call for bids for coal-handling equipment for power plant addition at institution at Yankton. Walter J. Dixon, Woefel Building, Mitchell, S. D., is engineer.

Tenn., Sevierville—J. A. Switzer, Knoxville, Tenn., consulting engineer, is at head of project to install a waterworks at Sevierville, to include installation of pumping machinery, filter system, storage tanks and auxiliary equipment.

Texas, Houston—Continental Can Co., 1 Pershing Square, New York, plans installation of electric power equipment in proposed new multi-story plant on tract of land at Houston, recently acquired, entire project to cost close to $400,000.

Texas, Houston—Pan-American Petroleum & Transport Co., 122 East Forty-second Street, New York, plans installation of electric power equipment in proposed oil refining plant at Houston, now being projected, entire plant to cost over $2,000,000. A boiler house will be built.

Texas, Houston—Shell Petroleum Corporation, Houston, plans installation of electric power equipment in connection with an expansion and improvement program at local oil refinery on Houston Ship Channel, entire project to cost over $200,000. Headquarters are in the Shell Building, St. Louis, Mo..

Texas, Sherman—Independent Ice Co., care of Albert C. Beckner, Wolfe City, Texas, recently organized by Mr. Beckner and associates, has plans under way for a one-story ice-manufacturing plant at Sherman, to be equipped for an initial capacity of about 20 tons per day.